MANIPULATIONS IN THE SCIENTIFIC ARTS.

PHOTOGENIC MANIPULATION:

PART I.

79

CONTAINING

THE THEORY AND PLAIN INSTRUCTIONS

IN THE ART OF

PHOTOGRAPHY,

OR

THE PRODUCTION OF PICTURES THROUGH THE AGENCY OF LIGHT:

INCLUDING

CALOTYPE,
FLUOROTYPE,
FERROTYPE,
CHROMOTYPE,
CHRYSOTYPE,
CYANOTYPE,
CATALISOTYPE,
PICTURES ON GLASS,
AND ANTHOTYPE.

BY

ROBERT J. BINGHAM,

LATE CHEMICAL ASSISTANT IN THE LABORATORY OF THE LONDON INSTITUTION.

Illustrated by Woodcuts,

EIGHTH EDITION.

LONDON:

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PREFACE

TO THE EIGHTH EDITION.

In this edition I have endeavoured to make such alterations and additions as shall put the reader in possession of all the improvements in the Photographic Art up to the present time. The principal of these consist in the introduction of several additional paragraphs on the glass process, and two or three methods of rendering the prepared glass plates much more sensitive to luminous influence; also, a new process for converting the *negative* glass picture into a beautiful *positive;* and some fresh matter descriptive of improvements effected by our neighbours, the French, in the paper processes.

R. J. BINGHAM.

Jersey, *June* 1851.

PREFACE

TO THE SEVENTH EDITION.

THE last edition of this little Manual having been sold in a very short time, which can only be attributed to the increased interest taken by the public in this fascinating art, has enabled me to include in this the Seventh Edition, all the improvements which have been lately made. Amongst other matters, a method of producing photographic pictures upon glass plates has been added, a process, judging from what has already been done, bids fair to rival the Daguerreotype in its great delicacy and beauty of detail, while it possesses many of the advantages of the Calotype process. I can assure the reader, that no trouble or expense has been spared, either by myself or the Publishers, to render this a practical Manual of the subjects on which it treats.

R. J. BINGHAM.

STOKE NEWINGTON,
January 1850.

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PHOTOGENIC MANIPULATION.

INTRODUCTORY REMARKS.

1. SEVERAL names have been given to this new art, and nearly all of them serve as definitions of it; it has been called Photography, from two Greek words,* meaning, drawing by light. MM. Niepce and Daguerre originally called their process Heliography,† or drawing by the sun; this name, being also derived from the Greek. Mr. Talbot has named a process patented by him, the Calotype, or, beautiful picture; this has lately been altered to Talbotype, in compliment to the patentee, and a process for producing photographs on metallic plates by M. Daguerre is known as the Daguerreotype, and for a similar reason.

2. To the Alchemists, with all their charlatanry, we are indebted for the germs of a great many important chemical discoveries. The early history of Photography is an illustration of this remark; for it seems that in their fruitless researches after the *Elixir vitæ*, &c., they obtained a compound, which we know as the chloride of silver, but which they called, from its appearance, horn silver, and so far back as the year 1556, they noticed that this substance was blackened by exposure to light; and we have on record one or two experiments, expressed, it is true, in a very mysterious way, but which appear to indicate that they had applied this property as a means of forming pictures.

3. Here the matter appears to have rested, until that

* From φως light, and γραφω to write, to depict.

† From Ηλιος the sun, and γραφω to depict, to draw.

eminent chemist, Charles William Scheele,* noticed that the chloride of silver was affected very differently by the different-coloured rays of light; it being blackened in the violet and blue rays, whilst pure red and yellow light had no effect upon it. But a still more extraordinary fact was observed, in 1801, by Ritter, of Jena, whilst repeating the experiments of Scheele; for he found, on throwing the solar spectrum upon a piece of paper impregnated with chloride of silver, not only that there was a greater blackening effect at the blue or more refrangible end of the spectrum, but that the paper was darkened beyond any of the *visible rays of light.*

4. These experiments of Ritter appear to have given rise to the idea, that there must be some *peculiar and separate fluid* accompanying light, which produces all the chemical changes we notice and attribute to mere *light.* Several modern philosophers have experimented upon this subject, of whom the most distinguished are Mr. Robert Hunt, and Sir J. F. W. Herschel. Mr. Hunt gave to this peculiar principle or influence the name of Energia,† from its being the "*energetic power of the sun* working in and producing changes in bodies," and Sir John Herschel, at a meeting of the British Association, proposed that it should be called Actinism, a compound term from the greek radical ἀκτιν (ray). Both these terms appear to be objectionable: the former, because it is not sufficiently definite, for it expresses nothing beyond mere energy or power, and an objection to the latter is, it is equally applicable to any other radiant force, for it may be used in connection with either heat or light; however, Actinism appears to be the name at present generally adopted. To return, however, to our short history. In the year 1800, the famous Dr. (afterwards Sir William) Herschel, in making some experiments on coloured glasses, prepared for the purpose

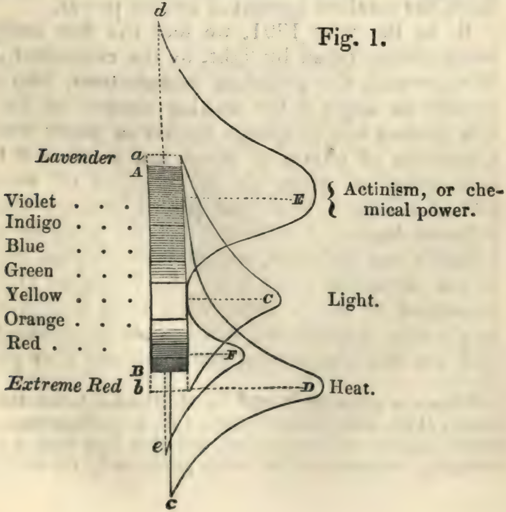
* Scheele Traité de l'Air et du Feu.

† Ενεργημα, Energema, Energy.

of defending his eye from the heat of the sun, when examining it with his large telescopes, noticed, that if he used a deep red glass, although it obstructed an immense quantity of *light*, yet it had little or no protecting influence from the heat. On the contrary, a blue or gray glass defended his eye very perfectly; this induced him to examine the subject, and he discovered that not only had the red ray of light the greatest amount of heating power, but that he could detect heat even below the red ray, in other words, he could detect heat in the spectrum without any light accompanying it.

5. This is an analogous experiment with heat, to that of Ritter's with regard to chemical power, and we are, therefore, led to divide the influence proceeding from the sun into three distinct and separate fluids, viz., "*Actinism*," Light, and Heat. The relation of these one to another, and their relative intensities in different parts of a decomposed sunbeam, are clearly shown in Fig. 1, in

Fig. 1.



which the various colours of the spectrum are indicated in the order in which they occur, between the points A and B. We have already stated that Sir William Herschel found the greatest amount of heat in the red ray; this is shown at D; from this point the curve of greatest heat declines, until it arrives at the lavender ray *a*, where it is altogether lost, but where the *actinic power* is greatest. It will be observed that this power extends to some distance beyond the spectrum as far as *d*. It also extends downwards as far as the luminous rays C, where a negative* influence is exerted, after passing which, the curve again increases, and a second maximum is found at F, the chemical power entirely ceasing at *e*, some distance beyond the *visible* rays. Upon reference to the curves formed in the diagram, it would appear that these three forces are antagonistic one to another; for where we have the greatest amount of light, there is the least heat, and where the greatest heat, the smallest amount of actinic power.

6. In the year 1801, we find the first notice of a picture being taken by light, by the celebrated Joseph Wedgewood, the porcelain manufacturer, who endeavoured to apply it for making designs for his ware. His process was to sponge leather or paper over with a solution of nitrate of silver, and to place it behind a painting on glass, or other object of which he wished a copy. The light passed through this with different degrees of intensity, and the paper or leather behind it was darkened, according as the glass was more or less permeable to its rays. Sir Humphry Davy also attempted to obtain impressions from images formed by the solar microscope; but neither this eminent chemist nor Mr. Wedgewood could prevent their pictures

* From a paper lately read by M. Claudet, before the Royal Society (17th June 1847) it seems that the yellow rays are not merely negative in their action, but that they have a positive destroying influence on the effects produced by the actinic rays.

changing on exposure to light: the same agent which produced, infallibly destroyed them.

7. In 1814, M. Niepce, of Chalons-on-Soane, turned his attention to this subject, and he found the resins to be curiously affected by the action of light, with regard to their solubility, and the result of his researches was the discovery of a process named Heliography. These pictures were produced upon metal plates, having the polished surface of the metal to form the shadows of the picture, and a resin producing the light parts: they were very indistinct, and wanted depth. M. Niepce, through accident, became acquainted with M. Daguerre, and they agreed to pursue their experiments together, and amongst other things tried the effect of sulphur and of iodine to deepen the shadows of their Heliographs; and it is extremely probable that M. Daguerre noticed a darkening effect in some of those plates, upon exposure to light, and that this laid the foundation for his brilliant discovery of the Daguerreotype, which was announced in 1839.

8. In January 1839, Mr. Fox Talbot sent a paper to the Royal Society, with an account of his discoveries in this branch of science. This was an account of the method he employed to prepare the ordinary chloride of silver papers, such as are now commonly used in copying the negative (§ 31.) photographs; also a method of "fixing them," by the use of common salt. In this way he was the first to produce a negative photograph *unalterable by light*, and therefore capable of having copies with correct light and shade taken from it. (§ 31.) This method he *gave to the world unrestricted by any Patent.* It is not surprising that the extreme beauty and novelty of these sun-drawn pictures, added to the great scientific interest attached to the processes, should have excited the attention of numerous lovers of science, who immediately began to investigate the subject, and

develop the chemical principles involved. Amongst them, Sir John Herschel and Robert Hunt stand in the first rank; it is to these gentlemen we owe the greater part of our present knowledge on the subject. They were the first to point out that papers prepared with the *pure* chloride, bromide, or iodide of silver, were quite unaffected by light, but that the smallest excess of a soluble salt of silver, such as the nitrate, rendered them exceedingly sensitive. This at once explained why papers prepared by Mr. Fox Talbot's first method were not all equally darkened, some of the sheets and parts of others still remaining perfectly white after a lengthened exposure, while others blackened very rapidly.*

9. In a process on glass plates by Sir John Herschel, resulting from some experiments he was making to determine the action of the organic matters of the paper on the discoloration of argentine compounds, he took advantage of this non-sensibility to light of the pure iodide of silver, and covered his plates with a film of the iodide, bromide, or chloride of silver, and kept them so until required for use; then by simply washing them over with a dilute solution of the nitrate of silver, they were at any time made exceedingly sensitive. (§ 86.) Another important improvement, viz., the employment of the hyposulphite of soda † for fixing the pictures by dissolving out the

* To overcome this difficulty, Mr. Talbot says,—"Having prepared a number of sheets of paper with the chemical proportions slightly different, let a piece be cut from each, and, having duly marked all, let them be placed side by side in a very weak light for a quarter of an hour; then, if any of them bears a marked advantage over its competitors, I select the paper which bears the corresponding number to be placed in the Camera Obscura."—*London and Edinburgh Phil. Magazine*, March 1839.

† In one of Mr. Fox Talbot's patents the use of this salt is claimed for dissolving the iodide of silver from the negative photograph, although previously used by Sir John Herschel in

unchanged silver salts, we also owe to this gentleman. In April 1839, Mr. Brayley, in a lecture at the London Institution, explained an extraordinarily sensitive method of obtaining sun-pictures, communicated to him by the Rev. T. B. Reade. This was by the employment of gallic acid, in addition to the iodide, bromide, or chloride of silver, previously used. In the year 1841, Mr. Fox Talbot obtained a patent for a method of obtaining pictures by light, which he termed the Calotype, in which was included several of the matters we have previously mentioned—amongst others, the use of paper prepared with the *iodide of silver, and rendered sensitive to light by the application of a solution of nitrate of silver and gallic acid.* It was, however, made more manageable by the addition of *acetic acid,* and for this valuable agent we are entirely indebted to Mr. Talbot; but surely this could give him no right to the sole use and benefit of the iodized paper, gallic acid, and several other matters included in his patent.

10. The photographic art has advanced since this time with great rapidity, and a number of different methods of taking pictures by sunlight have been published; the most important of which we shall endeavour to make the reader fully acquainted with, our object being to instruct him in all the *little requisites* so necessary to his success as a photographer, and at the same time to point out some of the chemical principles upon which the different processes depend.

APPARATUS AND MATERIALS.

11. *Paper for Negative Pictures.*—The selection

his processes both on paper and glass. He (Sir John Herschel) stating that the solution of hyposulphite should be used hot, from the difficult solubility of the iodide and bromide of silver, Mr. Talbot some time afterwards patented the use of a hot solution of hyposulphite of soda.

of good paper is the most important and troublesome matter the photographer has to contend with. There are a great many points to be attended to in choosing paper fitted for photographic processes. In the first place, it is essential the paper should be quite uniform in thickness. This may be ascertained by holding it between the eye and a strong light: a gas or candle light is preferable to daylight. It will be found on examining most paper in this way, that the sheet is full of irregularities in thickness, and very often minute holes may be detected. These defects exist mostly in very highly glazed thin papers. A moderately thick paper is not at all objectionable, provided it has been made without sulphate of lime; this is an impurity which occurs in some kinds and should be avoided. The paper should be well sized, for it is found that the organic matter in the size renders the paper, when prepared, far more sensitive; but it is also important in another respect, for the photographer will sometimes find that, upon applying the solutions, transparent patches will appear, *i. e.*, the solution will penetrate quite through the paper in some parts, while the rest will dry properly *on the surface.* This will be found to be the case in nearly all *new* paper. It appears to be essential that the size should have had some time to get hard and insoluble, for we have never found this defect in old paper. Several descriptions have been made by the manufacturers purposely for the calotype, &c.; but, being new, they are all more or less liable to this defect. It has been stated that this may be overcome by applying a varnish on one side of the paper, but we have not obtained any good results by this plan.

12. A paper having much blue in its composition should be avoided. The colouring matter contains several substances which considerably injure a good photograph. It generally gives a disagreeable dirty

appearance to the light parts. This defect exists in some of Whatman's papers, which otherwise would be excellent. A description known as thick yellow wove post, made by Turner, Chafford Mill, is decidedly the best paper we have found for the calotype process. It should be chosen as old as possible ; we have some which was made in 1840, and find it excellent; the only defect is that a number of little brown spots appear when the iodide of potassium is applied : these consist of iodide of iron ; but this defect is fully counterbalanced by other advantages. There is a fine kind of highly glazed drawing paper, manufactured by Whatman, on which very fine negative pictures may be produced, having their deep shadows and half-tints very perfect and clear : this paper is by some preferred to the thinner varieties generally used, being more easily manipulated with in the various washings to which it is necessary to submit the picture. Mr. Turner has lately made some paper, at the suggestion of Mr. Nicholson, purposely for photography, and has succeeded admirably ; and though perhaps this paper does not give such intense pictures as Whatman's drawing, it has a great advantage in the smoothness and *delicacy of detail*. For portraits, and where great quickness is required, a French paper, marked "Canson Frères," is the best that can be employed : when this is used, the pictures may be obtained in at least half the time of exposure in the camera required for other papers.

13. *Paper for Positives.*—For this purpose the texture is not of so much consequence ; and frequently paper rejected for negatives will answer very well for the printing process or positive. The operator will find that different kinds of paper produce varieties of colour and intensity in his photographs, and should therefore be selected according to the subject. An exceedingly smooth and well-defined photograph is

obtained on "Canson Frères'" positive paper; and this paper is well adapted for copying glass negatives, where much of the detail would be lost on the thicker papers.

14. In choosing paper for Mr. Hunt's Chromotype process, care should be taken to have no chloride in the texture of the paper, otherwise the pictures can never be rendered permanent.

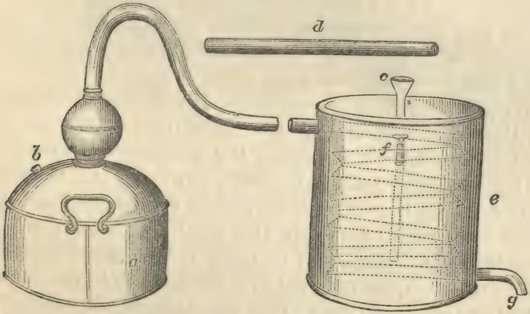
15. *Bibulous Paper.* — This should be without colour, and of the description called white machine wove; it has an even regular surface, which is an advantage. Fresh paper should be used for each stage of the process, and for each picture; but old paper may be used for absorbing moisture by interposing a clean piece at the back and front of the photograph, and it is as well to keep the paper used in the different processes distinct, for, should a piece of paper be accidentally used for drying a finished picture that had previously been employed in absorbing some of the sensitive solution, it would infallibly spoil it.

16. *Water.*—It has been recommended that the photographer should always use distilled water: this, in a great many of the processes, is not at all essential. Common water generally contains muriate of soda, and some sulphates, &c., in solution; and therefore, in making a solution of nitrate of silver, or in diluting a solution, we should avoid using it; for it will of course precipitate the silver in the state of chloride; rain or distilled water must be used in this case, although, where we cannot possibly get either, common water may be used, by allowing the precipitate, which is formed on the addition of the nitrate of silver, to settle. The only consequence is, that the solution will be rendered very slightly weaker by the precipitation of a small amount of silver. In all the other manipulations required, common water answers very well, and has this advantage,—the photographer need not be sparing

in the quantity used, and the picture may have a thorough washing without much expense. Distilled water may be obtained of any chemist, or the amateur may readily distil it himself.

Fig. 2. represents a convenient still for the purpose. The whole is made of tinned iron, and can be used on a common fire. *a* is the body, holding about a gallon of water, which is introduced at the opening *b*, which is then stopped by a cork. The

Fig. 2.



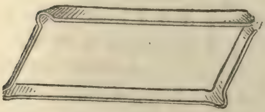
tube *d* connects the neck of the still with the worm tub or refrigeratory *e*, which is filled with cold water, a supply being kept up through the funnel *c*, the hot water is drawn off through the cock *f*; the different joints are rendered tight by lute, or, in the absence of it, some stiff paste spread on a piece of tape, and put round them answers very well. The distilled water is condensed in the worm, and passing off at the pipe *g*, is collected and preserved for use in a glass bottle. A glass retort connected with a Liebig's condenser forms a very convenient apparatus for distilling water, and may be heated either by an argand lamp, gas-light, or small chauffer.

17. *Brushes, and Methods of applying the Solu-*

tions.—The general method of applying solutions to the paper is by means of brushes, which for certain processes answer very well. They should be made of a soft material, and not bound with metal, for this has an injurious action upon several of the solutions; they may be obtained constructed purposely for the photographer. Each brush should be kept for its own particular solution; that used for applying the nitrate of silver must not be employed for the iodide of potassium, or any muriate, &c.; and they should always be well washed after use. In the absence of proper brushes, the solutions may be very readily applied by a sponge tied to the end of a piece of wood. This is an economical plan and good, inasmuch as, when contaminated in any way, it may readily be replaced; the only disadvantage is, that it is apt to disturb the surface of the paper. The brush used for applying the gallo-nitrate of silver in the calotype process is soon destroyed, and requires extreme care in washing, to remove all the gallo-nitrate, after each time of using; the smallest quantity left in the brush being enough to spoil a clean solution. Old gallo-nitrate appears to act in a similar way to yeast, and of which we have many other examples in chemistry; a very minute quantity sets up a decomposition in a clean and perfectly fresh solution. An instructive experiment on this point is the following:—expose a drop of gallo-nitrate of silver to sunshine, until it begins to darken, then take it into a dark room, and allow it to fall into fresh and clear gallo-nitrate that has not been exposed to light, and the whole will be found to become rapidly discoloured. [This, according to modern scientific parlance, would be called catalysis, or, *action by presence; i. e.*, some phenomena we don't know much about, and give it a *name* instead of an explanation.] The action we have just mentioned is the great source of failure in the calotype process, and too much care cannot be taken to keep the brushes, &c., perfectly clean.

A method of applying the solution, which removes this difficulty to a great extent, is to pour the liquid into a flat porcelain dish (Fig. 3.), or, what is better, upon the surface of a piece of plate glass, previously adjusted by set screws so as to be perfectly level, and then carefully to apply the paper so as to take up a certain amount of the moisture; this will become very easy after a few trials. After laying the paper upon the solution, the finger should be gently passed over the surface so as to press out any bubbles of air that might interfere, care being taken not to draw any of the liquid over the back of the paper. Before floating the paper on the solution, about a quarter of an inch in breadth at one edge should be folded upwards, so as to enable the paper to be lifted without staining the fingers; this part should, however, be previously moistened a little, so as to make the expansion of the paper uniform with that wetted by the solution. Mr. Nicholson has used for some time, for applying the sensitive solutions, a shallow dish, cut out of a thick piece of plate glass: this is a very clean, good, and ready method.

Fig. 3.



18. It is sometimes an advantage, and particularly in preparing positive (§ 31.) paper, when using a shallow earthenware dish, to draw the paper over the edge in taking it out of the solution; this will draw off the superfluous moisture, and leave an evenly moistened surface. Both the plate glass and the earthenware vessel should be well washed after each operation, and care should be taken that they do not get scratched; if so, it will be found that the gallo-nitrate will often remain in these scratches, and on pouring a fresh solution on the plate, and applying the paper, it will be

stained something in the same style that bookbinders call "marbling."*

19. *Chemicals—Nitrate of Silver.*—This should be crystallized, and not the common fused lunar caustic, the latter often being considerably adulterated with various substances; it generally contains both nitrate of copper and nitrate of potash; it is a little lower in price, but the crystallized salt will be found to be more economical in use. Any contamination with copper will be readily detected by the salt being deliquescent, and the pictures produced will be found not to be permanent. Another matter to be attended to is this: —nitrate of silver very often contains a quantity of free nitric acid: this may be readily detected by the smell, and it may be remedied by dissolving in distilled water, and driving it off by heat. In doing so, the salt will recrystallize, and a great quantity of the acid will have been driven off with the water.

The other chemicals required in the ordinary processes are,—iodide of potassium, bromide of potassium, and gallic acid.

Acetic Acid.—The strength of this acid should be known; it is generally sold containing very variable quantities of real acid.

Chloride of Sodium.—Common salt is an impure chloride of sodium, but answers very well. Various other chlorides have been used, such as the chloride of barium, strontium, calcium, &c., and which we shall refer to presently.

Hyposulphite of Soda.—This should be pure, and free from sulphuret of sodium. We give a method by which it may be prepared: one ounce of sublimed sulphur is to be mixed with one ounce and a half of lime,

* If clean water and gentle friction with the hand will not clean the vessels, a little nitric acid may be used, which will at once remove any reduced silver that may remain in the scratches or corners.

previously slaked by the addition of hot water, and the mixture put into a clean earthen vessel. Three quarts of water are added, and the whole is to be boiled for two hours. The clear liquid may then be filtered off into several wide basins or dishes, and allowed to remain freely exposed to air. When just made, the liquor is of a deep yellow colour, but by exposure to air it will become quite colourless. The time of exposure varies according to the strength of the solution, and the amount of persulphuret of calcium contained in it. This liquid, when colourless, is a solution of the hyposulphite of lime; it should be filtered before use. The hyposulphite of soda may be made by adding common carbonate of soda; a white precipitate will fall, which is carbonate of lime, and hyposulphite of soda will remain in solution.

20. *Different Methods of Preparing ordinary Photographic Copying-Paper.*—As we may by any of the simple means described in the following paragraphs obtain very beautiful copies of many natural objects with very inexpensive apparatus and materials, viz., a pressure frame and a few chemicals, we have thought it better, before considering the methods by which portraits and views from nature are produced, to describe the ordinary printing process by which copies of ferns, pieces of sea-weed, entomological specimens, lace, and engravings, &c., may be obtained. These photographs are very easily produced, and may serve in some degree to habituate the tyro to photographic manipulation before he commences with camera pictures, which require a little more attention in their management.

Nitrate Paper.—If we brush a solution of nitrate of silver, having about 100 grains of the salt dissolved in an ounce of water, over a piece of paper, and allow it to dry, we shall have a paper moderately sensitive to light; about one hour's good sunshine will

completely blacken it. This paper will serve very well for copying lace, leaves, ferns, &c.; and there is this advantage in using it, the picture can be fixed by soaking in hot water. The experimentalist will find very different effects in using different sorts of paper. A highly-sized paper answers best with the simple nitrate of silver; it appears to combine with the size, and form a sensitive surface. By soaking in hot water, all the undecomposed nitrate of silver and size is dissolved out together: but, however, this is far from being the best or most economical process.

21. *Papers prepared with the Chloride of Silver.*—If we form a solution of nitrate of silver, and then add to it a solution of chloride of sodium, a white bulky precipitate will fall, which consists of chloride of silver, whilst there will remain in the solution nitrate of soda. The following diagram will roughly explain this interchange of substances.

Common Salt.

Chloride of Silver.	Chlorine.	Sodium.	Nitrate of Soda.
	Silver.	Nitric Acid.	

Nitrate of Silver.

From this it will be evident that if we wash paper over, first, with chloride of sodium, and allow it to dry, and then wash it over with nitrate of silver, the above interchange will take place, and the insoluble chloride will be precipitated in the pores of the paper. This forms an extremely sensitive surface, when a little excess of nitrate of silver is present; hence, in giving the following proportions for sensitive papers, care has been taken to allow this excess to be present, for it is a curious fact, but well worthy of attention, as it is of

importance in the *calotype* process, that neither the chloride, iodide, nor bromide of silver, is sensitive to light when perfectly pure and free from organic matter. We give the proportions for forming the chloride papers.

22. Dissolve 60 grains of common salt in 3 ounces of water, (it is not necessary it should be distilled water), then weigh 60 grains of nitrate of silver, and dissolve this in one ounce of *distilled water;* dip a sheet of good writing-paper in the solution of common salt, absorb the superfluous moisture by bibulous paper, or a clean dry cloth, and then allow it to dry; then brush over the surface the solution of nitrate of silver,—this must be done rapidly and evenly. Should any part of the paper not have been touched by the brush, that part must not be filled in separately, but the whole sheet must be brushed over again very regularly; care must be taken that the solution should be evenly spread over the whole surface alike, otherwise part of the paper will exhibit black patches on exposure to light, before the other part is sensibly darkened. The silver solution may be applied by means of the porcelain dish, as explained (§ 17.); this paper should be allowed to dry in the dark, and when dry will be ready for use. These proportions may be varied according to the colours wished to be obtained in the finished drawing; it will be found, by using an *excess* of salt, that the paper will not be very sensitive, and it will darken to a disagreeable light slate colour, and there will be no depth in the picture; a less proportion of salt will give a very sensitive surface having a dark-slate colour, a still less quantity gives a great depth and blackness in the drawing, and a smaller quantity will give a rich bronze colour, and so on, passing through all the shades of brown until we come to a very red brick colour having little depth. These principles will serve to guide the amateur, who will thus be enabled to vary the colours, and

obtain any tone of picture his taste may dictate. The same rules will also hold good with the bromide paper, which we shall now give directions for preparing.

23. *Bromide Paper.*—Dissolve 60 grains of bromide of potassium in 3 ounces of water, and soak the paper in the solution; absorb the superfluous moisture, and then wash it over with a solution of nitrate of silver having 100 grains to the ounce, observing the same precautions as with the chloride paper; if required to be very sensitive, it may receive a larger quantity of silver. This is a very sensitive paper.

24. The fluoride, tartrate, benzoate, and iodide of silver, have all been used, and they all modify the colour and the quickness of the picture very considerably; and, in preparing the chloride papers, it will be found that the results will vary considerably by using different chlorides:—viz. the chloride of barium, used in the same proportion as the other chlorides, gives rise to a picture having a deep red ground; the chloride of calcium, the chloride of lime, muriate of ammonia, muriate of iron, and the chlorate of potash, recommended by Mr. Cooper, the vapours of muriatic acid, recommended by Dr. Schaffhautl, and a great number of others, all modify the results considerably.

25. *Ammonia-Nitrate of Silver Paper.*—The best and most economical photographic paper is prepared with the ammonia-nitrate of silver, which was first used and described by Mr. Taylor. The solution of ammonia-nitrate may be substituted for the simple nitrate silver in the previously described chloride, bromide, and iodide papers; the same preparation with common salt or bromide of Potassium being necessary. On washing a solution of ammonia-nitrate of silver over a paper prepared with the former, a similar decomposition takes place as described (§ 21.), a quantity of chloride of silver is formed, and, if the

proportions are correct, a small quantity of free ammonia-nitrate is left on the paper.

26. Dissolve 30 grains of nitrate of silver in one ounce of distilled water, then cautiously add, drop by drop, strong solution of ammonia (*liquor ammoniæ*), until a precipitate of oxide of silver which is at first formed, is re-dissolved. Care should be taken that no more ammonia be added than is sufficient to effect this. The tint of the picture may also be varied by adding more or less ammonia: two or three drops in excess produce a blackish tint.

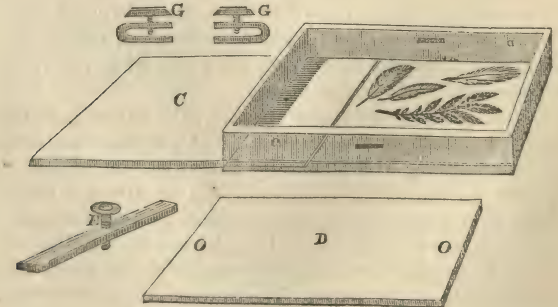
The following is another method of preparing this kind of sensitive paper:—Dissolve 60 grains of nitrate of silver in some distilled water, and then add ammonia until it ceases to precipitate any more oxide of silver; allow the precipitate to fall to the bottom of the vessel, and then pour off the solution of nitrate of ammonia which has been formed, add some distilled water, allow the oxide to settle, and again pour off the liquid; repeat this two or three times, you will then have oxide of silver moistened with a little pure water; now add ammonia, drop by drop, until the oxide is *nearly* all dissolved, and add distilled water until an ounce of solution is obtained. By this means a solution is procured without any nitrate of ammonia being present, and the pictures produced are free from the red tone which is thought disagreeable by some persons. A very warm tint is produced by dissolving the oxide of silver in a solution of nitrate of ammonia.

27. In preparing these papers, the experimenter should be cautious not to touch the prepared surface with his fingers; this generally gives rise, on exposure to light, to annoying representations of the markings of the skin, from the communication of organic matter, which, as already stated, quickens the action of light. It is also a necessary precaution to mark the prepared side of the paper. The ammonia nitrate paper,

and indeed all the very sensitive papers, should not be made more than a few hours before they are required for use; they become yellow and discoloured by long keeping.

28. *Making the Photograph.*—We have now described several methods by which paper may be prepared in such a way that it will very quickly blacken all over, if exposed to light; but it will be obvious that, if we shaded any part and exposed the other, the part covered would still remain white, and the whiteness would correspond to the form of the body shading it. If a leaf be placed upon a sheet of such prepared paper, and exposed to sunshine, the paper will become black all around the leaf, but underneath it, it will not have been blackened, except partially, under those parts of the leaf less opaque than the rest. The light will shine through these parts with different degrees of intensity, and there will be a corresponding marking; the fibres of the leaf will shade more light than some of the other parts, and therefore will remain white; but it is necessary, in order to obtain a perfect copy of the leaf, that no other light should get to the paper under the leaf, than what would shine through the more transparent parts. For this

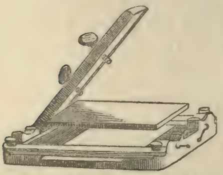
Fig. 4.



purpose, it is necessary that the object to be copied should be pressed close to the paper.—An apparatus contrived for this purpose is shown in Fig. 4. It consists of a thick piece of plate glass fitting into a frame; upon this glass, the object to be copied is placed, and over this the sheet of prepared paper; the board D is then laid over the paper, and the requisite pressure applied by means of a cross piece with a screw E. These frames are sometimes supplied with a sliding cover of wood C, by which the paper can be exposed to light when convenient.

29. An improved form of pressure-frame is shown at Fig. 5; by which greater force can be used, and consequently closer contact obtained between the positive and negative photographs, and it can be more readily opened so as to see the progress of the printing process.

Fig. 5.



In copying an object which has thick parts, as the stems and thick fibres of plants, it is requisite to press the paper over them close to the glass; this is done by putting a thick piece of flannel or a soft cushion in the pressure-frame beneath the paper, or the stems may sometimes require paring down with a penknife when too thick.

30. Engravings may be beautifully copied by this process, particularly when they are moderately strong in light and shade: they should be placed with the printed side downwards upon the piece of prepared paper (which should be perfectly dry, otherwise it might spoil the print), and secured by a small piece of paper at the corners, or, what is better, two or three pieces of gummed paper; it may then be examined from time to time during the exposure, without risk of

disturbing its position; it may be allowed to become a little darker than required when finished, the fixing process tending to lighten it. Ferns form exceedingly beautiful objects. Sea-weeds, feathers, wings of insects, and paintings on glass, serve to diversify the specimens. They should all be pressed as closely as possible to the glass, otherwise there will be a want of proper definition in the photograph. Engravings should be chosen which have been printed upon even and uniform paper; for, in copying the engraving, we also copy all the defects of the paper: they should also have no writing or printing upon the back, for this would also be copied.

31. In the first copy of a print by this process, the light and shade will not be true to nature; the dark parts of the picture will obstruct the greatest amount of light, consequently the paper will remain white underneath these shadows, while the white parts of the print will allow the light to shine through; therefore the photographic paper will be darkened just in proportion to the light and shade, but in an opposite manner. This is what is technically called a *negative* photograph; and in order to obtain the light and shade true to nature, or a *positive* * photograph, we must place the negative copy (of course, having previously fixed it so that the light no longer acts upon it) (§ 35) upon another piece of prepared paper, and expose this arrangement again to sunshine; this will again reverse the light and shade, and this copy will, therefore, be correct.

In this way the negatives produced in the camera are copied, being generally secured to the prepared paper by a portion of wafer or gummed paper; but as a great number of copies are sometimes required, the negative is liable to get torn by this

* The terms negative and positive were first proposed by Sir John Herschel.

method. Mr. Heinecker has contrived an addition to the pressure-frame, which overcomes this inconvenience. The negative and positive being allowed to project a trifle beyond the glass, are secured together by a steel-spring hinged at one end of the frame, and, being slightly curved when forced straight, and fastened by a small catch at the other end, exercise sufficient pressure on the edges of the papers to keep them firmly together. Two negatives may be copied at the same time, and either removed without disturbing the other.

32. A pretty method of multiplying designs is the following, which we owe to Mr. Havell:—Cover a piece of glass with a coating of black varnish, and then with a steel point remove the varnish, according to any design you may wish to multiply; a piece of photographic paper placed underneath this will, of course, be blackened where the varnish has been removed, and an exact copy of the design will be made; in which way any number of copies can of course be made; but this requires some artistic skill; nevertheless we have seen some very beautiful specimens produced in this manner. The following is, perhaps, an improvement:—A piece of ordinary photographic paper is blackened all over, by exposure to the sun, and then submitted to the fixing process (§ 37.), we should then prepare a solution of cyanide of potassium moderately strong; and with a quill pen trace any design we may wish to have multiplied: this will remove the blackened surface, or in other words, dissolve the oxide of silver from the paper; it should then be washed in water and dried, when it may be used as a negative, and any number of positive (§ 31.) pictures may be produced from it.

33. *Time of Exposure.*—This will, of course, vary with the degree of sensitiveness imparted to the paper, and the degree of opacity in the objects to be copied,

the strength of the light, &c.; but the operator will easily determine this in a few trials. It is as well to make the impression rather darker than you wish it to be when finished; for the fixing process hereafter described (§ 37.) will render the photograph a shade or two lighter. It is sometimes an advantage to make the engraving, or negative photograph, more transparent; this may be done by warming it, and then rubbing it over with white wax, and absorbing the excess by bibulous paper; or it may be covered with Canada balsam, or boiled linseed oil. These substances, however, have a tendency to make the paper yellow, unless used very sparingly, which effect would just defeat the object we had in view in using them, viz.—to obtain a copy more quickly.

34. *On the Chemical Change produced.*—We will now briefly notice the change which has been set up by the action of the light, and for this purpose will relate a very instructive experiment made by Mr. Hunt, which will give a clear view of the subject. That gentleman prepared some very pure chloride of silver, and placed it in a glass tube containing a little pure distilled water; the tube was then hermetically sealed, and exposed to light; the consequence was, that the chloride became darkened, or in other words, it was decomposed into its elements, viz. silver and chlorine; the dark powder being silver and oxide of silver in a state of minute division, and the chlorine formed a solution in the water. This was proved, by breaking the tube and pouring off the water; a solution of nitrate of silver was then added, when an immediate precipitate of white chloride of silver took place; which was collected and weighed. A little dilute nitric acid was then added to the darkened chloride; this dissolved any silver that might be present; and it was found, on calculation, to be exactly equivalent to the amount of

chlorine found in the distilled water. The first action in these papers, when exposed to light, is this,—the chlorine, bromine, or nitric acid, with which the silver is combined, is set free, and dark oxide of silver is left in the paper. A still greater exposure to light sets free the oxygen, and metallic silver is left; this forms the dark parts of the picture, and the undecomposed chloride of silver the lighter parts. We have, therefore, a complete picture, but which would not bear exposure to the light; for this would act on the remaining chloride in the lighter parts of the picture, and darken it; our picture would, therefore, disappear, and we should have a mere black sheet of paper. The object with the photographer will now be, to remove this chloride of silver from the unsunned parts, without injury to the oxide of silver in the shadows. This we shall consider in describing the

35. *Fixing Process.*—It is known to chemists that the chloride of silver is soluble in a solution of ammonia; we may, therefore, dissolve the undecomposed chloride out of the paper by this agent; and it does so very effectually; but, unfortunately, it also has the property of dissolving oxide of silver. We shall, therefore, have our picture moderately well fixed by soaking in ammonia; but without great care, the oxide of silver forming the shadows will also be dissolved out. The ammonia used as a fixing agent should be rather weak.

36. Common salt has been recommended by Mr. Fox Talbot to fix the photograph. In this case, the action is also by dissolving out the chloride of silver, that substance being soluble in chloride of sodium or common salt; it is probable, however, that this substance also acts, to a certain extent, by getting rid of any excess of nitrate of silver, by converting the whole into a chloride,—the chloride being almost insensible to light, provided free nitrate of silver is not present, as before stated (§ 21.); however, organic mat-

ter is always present, which, as well as free nitrate of silver, determines the blackening action of light. Photographs soaked in a solution of common salt are therefore but imperfectly fixed; they should always be washed in abundance of water after immersion in the solution of salt. Iodide and bromide of potassium may be also used with like success, the rationale being the same.

37. But the best substance to use is a salt called the hyposulphite of soda, and by proper precautions pictures may be perfectly fixed by it.

The photograph should be placed in a flat porcelain dish, Fig. 3, and wetted throughout with cold water; a quantity of hot water should then be poured upon it and allowed to remain a little time; this will shortly become milky from the quantity of muriates and sulphates contained in ordinary water (§ *21.*): it should then be poured off, and a fresh quantity of hot water placed in the dish; it may now be allowed to stand in a shaded place until quite cold, and the photograph then rinsed with a little common water, and pressed between folds of blotting paper. The picture is now moderately well fixed, but not perfectly; all the size and nitrate of silver will have been dissolved out of it, but a little insoluble chloride of silver will still remain; a solution of hyposulphite of soda should then be prepared, having about a quarter of an ounce of the salt dissolved in a pint of water; a little of this should then be poured into a flat dish, and the photograph placed in the solution; in about half an hour the hyposulphite will gradually have dissolved out the silver, and a red appearance will be given to the drawing; the picture should now be withdrawn and placed in a vessel of cold water, and allowed to remain a considerable time, or until the water in which it is soaked is quite tasteless; and, if required to be very carefully fixed, should be washed and left for some hours in several quantities of rain water. The hyposulphite of silver is very soluble, and it is a curious fact that

it has an extremely sweet taste. It is an advantage to press all the water out of the paper once or twice before putting it into fresh water, as it is quite necessary to get rid of all this hyposulphite of silver, for if any remains the photograph will gradually fade and nearly disappear. It is as well to remind the amateur that, from the extreme solubility of the hyposulphite of silver, a great *quantity* of water is required rather than long soaking. The paper should be pressed between clean bibulous paper, and then completely dried by the fire. It very often happens that the picture assumes, after fixing, a very red disagreeable appearance: this may be obviated by altering the proportions of the salt and silver. (§ 22.) Another method of obtaining different tints has been adopted by some French operators: this is done in the following manner, —prepare a solution of hyposulphite of soda, containing eight drachms of the salt to half-pint of water; to this add ten drops of any acid—acetic is perhaps the best; immerse the calotype in this mixture at once, without any previous washing, and allow it to remain until it changes to the desired tint; at first it will be red, then alter to a brown, then to a black, and lastly pass to a greenish yellow: these changes will take several hours. After it has attained the desired colour, it should be removed from the hyposulphite bath, and well washed, and left in clean water for several hours, when it may be removed and dried by bibulous paper. The same solution of hyposulphite may be used repeatedly, a little fresh being added from time to time. The rationale of the alteration in colour is this:—the hyposulphite of soda is very readily decomposed by acids, with the liberation of sulphurous acid and free sulphur;* but if there be an excess of the hyposulphite of soda, the sulphur dissolves in it,

* Our chemical readers will more clearly see this reaction by the formula $Na\ O, S_2\ O_2 + Ac\ O_3 = Na\ O, Ac\ O_3 + S, O_2 + S.$

forming a solution of a sulphuretted hyposulphite; when the photograph is placed in this mixture, the sulphur combines with the reduced silver (§ 34.), and forms black sulphuret of silver; this gives the shadows of the picture, at the same time the hyposulphite of soda dissolves the chloride and nitrate of silver from the white parts: it must, however, be observed, that pictures treated in this way are not perfectly fixed, for whenever we get *sulphuret* of silver, although at first a beautiful black, it will inevitably oxydize by the action of the light and the oxygen of the air, and form the pale *sulphate* of silver.*

38. We have for some time practised a method of changing the colour of fixed photographs, which is very simple:—To a pint of water add one drop of hydrosulphate of ammonia; immerse the fixed picture in this; it will shortly change from a red, through all the different tints of brown, to a beautiful black, and at last to a greenish yellow; it should then be well washed in water and dried. This is a severe test, for if all the silver has not been removed from the white parts by the fixing process, the picture will become dusky all over; but, if it has been well fixed, the lights of the picture will not suffer in the least. The reaction in this case is precisely the same as we have before described. The pictures are equally liable to fade after a time, but, if preserved from the air, will keep for some years.†

39. *Albumenized Paper for Positives.*—By the fol-

* This is rendered certain by some late researches of Professor Schonbein on the metallic sulphurets. He states that all these substances are oxydised when acted on by light and air.

† A patent has lately been obtained for the *better fixation* of photographs, in which sulphuretted hydrogen is used for darkening the picture after it has been submitted to the improved fixing process. It is but due to Mr. Robert Hunt to state that he described this application of sulphuretted hydrogen to the darkening and altering the colour of photographs, in a treatise on the art of photography, published in the year 1841, by Griffin & Co.

lowing means we obtain very brilliant proofs. We give the method adopted by Mr. Blanquart Evrard, the author of the process:—To four ounces of the clear liquid of the white of eggs, add 60 grains of common salt, dissolved in 1 ounce of distilled water, beat up into a froth, allow it to return into a liquid, and then pour it into a flat earthenware dish (fig. 3); now very carefully depress upon this a sheet of paper, so that one side only is wetted; allow it to float for half a minute, then carefully and gently raise it; allow it to drain for a minute, and suspend it by a pin at one corner until dry; when a few of these have been prepared they should be placed under a strong pressure between folds of paper until quite flat. To render a sheet sensitive to light, pour into another dish a solution of nitrate of silver, containing 120 grains, dissolved in one oz. of distilled water; upon this liquid lay a sheet of the albumenized paper, let it remain for two minutes, raise it gently by one corner, let it drain, and then dry it slowly before the fire; it is then ready to receive the impression. The method of fixing is precisely the same as for the foregoing processes. Instead of using paper for a support to the albumen, we may use any other transparent material; when glass is used it forms very beautiful slides for the dissolving views or magic lanthorn. See also § 81.

40. *Application.*—Mr. Fox Talbot has patented a great number of applications of this new art, and has exercised great ingenuity in anticipating some purposes to which it may be applied.

Photography has been applied as a means of making the designs upon blocks of wood for woodcuts and for calico printing; for this purpose the surface of the block is washed over with the solutions in the same way as they are directed to be applied to paper, and they may undergo the same processes in fixing.

It is a curious and interesting fact, that nearly all paper photographs may be rendered invisible, and

again restored at pleasure. If a photographic picture be dipped into a solution of corrosive sublimate (the strength of the solution is of no material consequence), the picture is observed gradually to fade, and after a time, varying according to the strength of the solution, it will entirely disappear. It may thus be preserved for an indefinite length of time as an apparently blank piece of paper, but can at once be restored by washing it with hyposulphite of soda; the rapidity with which its restoration is effected is almost marvellous.*

CAMERA PICTURES.

41. We have hitherto described the most simple kind of photographs,—those produced by direct radiation *through* the object to be copied; but the most interesting and important variety of sun pictures are those produced by light, reflected from the object to be copied upon the prepared surface; in order to produce these results, the manipulation is a little more complicated: but the effects produced are well worth the additional trouble and expense. We allude to the method of obtaining views and portraits *from nature* by means of the Camera Obscura, an instrument which it is necessary to describe at some length, as upon its perfection a good deal of the success of the amateur will depend.

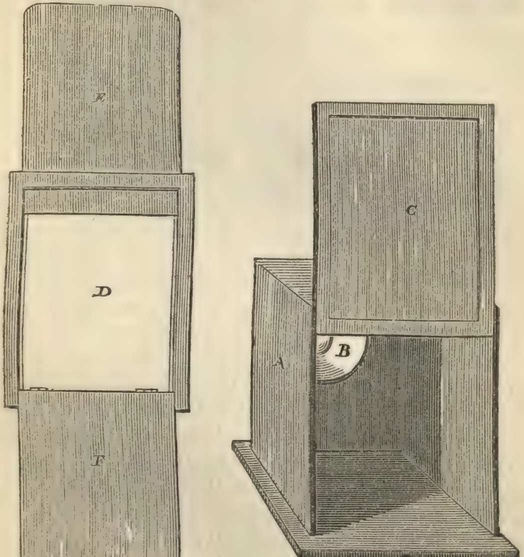
42. *Camera Obscura.*—This instrument has hitherto been described in optical treatises as little more than a philosophical plaything; the requirements of photography have, however, induced opticians to make modifications in its construction, and almost every optician has altered it to suit his own particular fancy.

43. Fig. 6. represents the most simple and inexpen-

* If the photograph produced upon a dark surface, as stained boxwood or ebony, is immersed in corrosive sublimate, all the black shadows of the pictures will be changed into white; thus we shall obtain a white picture on a black ground. In this manner we may obtain either a "positive" or "negative" at will. (§ 97.)

sive form of the apparatus; it consists of a wooden box A, having at one end a meniscus or concavo-convex lens screwed into a sliding brass tube B, so as to be able to push it toward or away from a piece of dimmed glass C

Fig. 6.

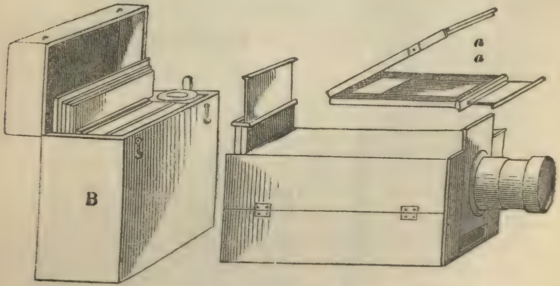


which is enclosed in a frame, and made to slide into a groove at the other end of the box. On pointing the camera at any object, there will be a reduced representation of it on the ground glass C, more or less clear; but this image may be rendered quite distinct by adjusting the distance of the lens from the ground glass. D represents the sliding frame for holding the prepared paper, this fits into the same groove in the camera as

the ground glass, and is provided with a sliding door E, so that the light can be made to fall on the prepared paper after its introduction into the camera; the paper is affixed by one or two morsels of wafer upon the door F, of the frame.*

44. *Portable Camera.* — Fig. 7. represents a far

Fig. 7.



more complete and convenient form of camera; the sides of the box, A, are hinged together, and so contrived that, upon taking out the back and front, it folds into a very small compass, and the whole can be packed into the box, B; the slide for containing the paper is also very convenient, inasmuch as it is so constructed that two pieces of prepared paper may be enclosed and exposed to light in succession, it is shown at *a a*. The pieces of paper are laid, the prepared side downwards, upon the squares of glass *a a*; the two halfs of the slide are then folded together, and secured by a brass clasp at each side. Upon reference to Fig. 7. it will be seen that one slide is represented as drawn upwards, this would let the light act upon one piece of paper; this shut down, the frame

* A very convenient form of camera for small pictures has been fully described in the Philosophical Magazine, by Mr. Cundell.—*Phil. Mag.*, No. 160, May 1844.

turned round in the camera box, and the other drawn up, would then uncover the other piece.*

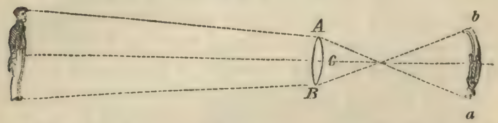
45. But a very convenient and useful modification in this camera, is the sliding front; the part of the camera front bearing the lens is made to slide in a dovetail in the other part of the front, so that the operator is able to raise or depress the lens to the extent of about one inch or one inch and a half. In raising or depressing the lens, we also raise or lower the *horizontal line* of the landscape (or other object at which the camera is pointed) upon the ground glass; now, as will be seen in our directions for taking views, it is absolutely essential in order to obtain correct perspective—for example, in copying a building—that we should not raise the camera at an angle, but that it should be perfectly horizontal. Now, supposing the operator to be standing on the ground, it will be found that if the camera is horizontal, one-half of the picture will be occupied by the object we wish to have represented, and the other half by the foreground, which we could just do as well without, and it is very probable the effect of the picture will be spoiled, by some of the upper part of the object not being represented. Now this difficulty is completely overcome in this case, by raising the object-glass a little higher, when part of the ground will be cut off, and the whole of our object represented, without having to move the camera out of its hori-

* The interior of this box has always been blacked, in order that any stray rays of light, not directly incident upon the photographic paper, should not be reflected upon it from a light surface. M. Laucherer, of Munich, a very successful operator, has lately stated that we are in error in this, that the interior of the camera should be perfectly white: he considers the image is thus obtained in half the time, that there is greater uniformity in the impregnation, and that the lights are not lost before the full development of the parts in shadows. No doubt in some cases it might be used with advantage, but in most instances we should prefer operating with a blackened camera.

zontal position; consequently, the true perspective will be retained.

46. As some little care is required in the construction of a camera, it may be as well to make the reader acquainted with two or three points to be attended to, and some of the optical principles on which its use depends. Fig. 8. represents the lens, and the directions of the

Fig. 8.



rays of light in forming the image. If we hold a double convex lens opposite any object, we shall find that an inverted image of that object will be formed on a piece of paper held behind it; but the lens being doubly convex, the rays which pass through it will go to the *same distance* from every part of its surface, therefore the image *a* will be formed in the same curve as the lens A. This may be corrected to a great extent by using a lens of the periscopic form; this was first suggested by Dr. Wollaston: by this means the rays *a* A, *b* B, are rendered longer than the central rays, *c*, *c*. This lens, when used in the camera, should have the concave side towards the object, and in order still more to reduce the error of figure, a small diaphragm should be placed in front of the lens. The diagram,

Fig. 9.

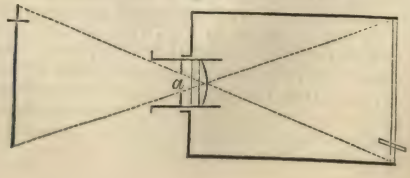
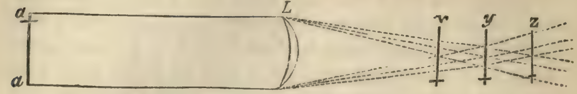


Fig. 9. represents this arrangement, and the position of the stop is shown at *a*, when it will be seen that it just admits the rays of light from the object, and no more. If a stop, having the *same opening*, had been placed farther in advance of the lens, it is evident that it must have cut off some of the rays of light from the upper and lower parts of the figure, or if the tube had been made longer, the same effect would have taken place; this is a very common fault in the construction of cameras, and should therefore be attended to.

47. By using a small diaphragm in front of the lens, we are enabled to cover a greater extent of surface, and more correctly, than by using a larger opening, but it is at the sacrifice of light; for the larger the aperture we employ the greater will be the amount of light upon the prepared surface, and we shall obtain a picture more quickly; but in order to obtain the greatest amount of distinctness, we must employ a very small opening. It is better that the operator should have two or three sizes, of about half, three-fourths, and one inch and a quarter in diameter: and supposing the lens to be nine inches in focal length, we shall be enabled, by having an opening of about three-fourths of an inch, to cover a surface of nearly five inches square. As a general rule, with a moderately small opening, a lens will cover a square surface of about three-fifths of its focal length; that is, supposing a lens to be of twenty inches focus, it will enable us to have our prepared paper three-fifths of twenty inches square = twelve inches square. This is a general rule; for, of course, if the object is very close to the glass, the distance of the paper from the lens will have to be increased, and instead of twenty inches focal length, it may be twenty-five or twenty-six, and the size of the paper may be increased in proportion.

48. Another important matter to be attended to, is what is called Chromatic Aberration, Fig. 10.

Fig. 10.



Let *a* represent a ray of white light falling on the lens L; it will not pass through colourless, but will suffer decomposition into the primitive colours of which white light is composed. Now all these colours have a different degree of refrangibility, or are *more* or *less* bent out of their straight course; therefore they will all have a different focal distance for the image *a*, *a*; the visual focus, or that of the yellow ray, being at *y*, whilst the focus for the violet rays will be at *v*, and for the red at *z*. It has been stated (§ 5.), that the rays by which the photographic image is produced are the violet, whilst those which act most intensely on the organ of vision are the yellow; it will therefore be evident, that, when we adjust the focus of the camera, we shall obtain the focus of the yellow ray, whilst the image produced by the violet rays will not be properly defined; it is necessary, therefore, after having obtained the best visual focus, to push the lens a little nearer the paper so as to get the violet rays to act on the paper. This distance is about one-thirtieth of the whole focal length of the object glass, with a moderate-sized opening; with a smaller diaphragm the chromatic aberration will be a little less apparent in the picture, but as a general rule, the lens should be pushed in one-thirtieth of the focal distance, after having obtained a distinct and well-defined image. It will be found convenient to have a scale marked on the sliding brass-tube, indicating the proper adjustment; but this being of far greater importance in the delicate pencillings of the Daguerreotype, we have described, in Part 2 of this

work, two instruments adapted for ascertaining the chemical focus with great exactness.

49. Lenses are made with a combination of glasses, in which this chromatic aberration is overcome. A great amount of attention has been paid to this point, and combinations of lenses are now made beautifully achromatic, but the expense is considerably increased, and for the processes on paper we can recommend, from our own experience, a single meniscus lens, and believe that, if *properly adjusted to* the chemical focus, equally as good pictures may be produced by it as by a more expensive form; however, as this correct adjustment is troublesome, an achromatic meniscus may be used, if the additional expense is not an object.

CALOTYPE OR TALBOTYPE.

50. *Photographic Paper suited for the Camera.*—The sensitive papers hitherto described may be used in the camera, but they require such an enormous time to produce an image that they are almost useless, two or three hours exposure being generally necessary, whilst by the Calotype and some other methods a good impression is frequently obtained in a few seconds. Mr. Fox Talbot, after making a number of experiments on the process with gallic acid, was the first to produce perfect specimens in this way. The exact proportions which he used were patented by him; since that time many improvements have been made. The following we consider the best and most certain method now in use. Before, however, describing the process, we shall enumerate the apparatus required.

Two or three flat porcelain dishes for holding the solutions of iodide of potassium, nitrate of silver, hyposulphite of soda, distilled water, &c. Fig. 5.

A sheet of plate glass, supported upon adjusting screws, to apply the gallo-nitrate.

Camel or badger hair brushes.

A graduated glass to measure out the gallo-nitrate; this should not be made too narrow, but should admit of being readily cleaned; this cleaning being absolutely essential after every time of using, inattention to which will cause many failures.

A board for laying the paper upon whilst applying the solutions.

51. *1st Preparation of the Iodized Paper.*—The paper having been selected with the precautions before stated (§ 10.), it should be laid upon the board, having two or three sheets of blotting paper underneath it, so as to absorb any moisture that may by chance get over the side of the paper; it should be held by the finger at one corner and washed over by candle-light with a solution of nitrate of silver, having about 20 grains of the salt dissolved in one ounce of distilled water; this should be allowed to dry at a little distance from the fire, and then altogether immersed in a solution composed as follows:—

Dissolve in a pint of water—

250 grains iodide of potassium,
125 „ chloride of sodium (common salt),
125 „ bromide of potassium.

It may be allowed to remain for about half a minute in this solution, so as to insure the whole of the previously applied nitrate of silver being converted into the mixed iodide, chloride, and bromide of silver, for should there be any free nitrate of silver left in the paper, it will be liable to darken spontaneously, and the operator will be annoyed by finding that upon applying the gallo-nitrate to excite the paper, it will blacken all over; at the same time, care should be taken that it does not remain *too long* in the solution, for if it should, the iodide of silver being very soluble in iodide of potassium, the whole will be dissolved out.

52. The object of the operator in this part of

the process being to leave an iodide of silver in the pores of the paper, perfectly free from impurity, it is necessary, after the paper has been immersed in the iodide of potassium, to remove the excess of this salt and a nitrate of potass, which is formed, by well washing in common water. For this purpose he should provide himself with three or four large vessels of water, and after the first piece of paper has been immersed in the iodide of potassium, it should be placed in vessel No. 1 and gently agitated, and left until the next piece of paper is ready for washing, when the first iodized piece should be removed into vessel No. 2, and the second piece of paper submitted to the same washing and agitation as the first, and so on, until the first prepared piece has passed through three or four vessels of water, when it should be taken out and the superfluous moisture removed by clean blotting-paper, and then *left to dry spontaneously*; the paper should then be *preserved in a portfolio* until required for use.*

53. We have sometimes found it an advantage when washing the paper, to let a drop of the water from the paper fall into a solution of nitrate of silver; if there should be a precipitate, it will indicate that the whole of the iodide has not been washed out; but should there be no precipitate, the operator may consider that the soluble salts have all been removed. This is a useful test in two respects, first, because the paper should not be washed more than is absolutely necessary, for it has a tendency to make the paper

* It may be easily ascertained if the paper has been soaked for a sufficient time in the iodide solution; for, if properly prepared, the iodized paper will bear some hours exposure to strong sunshine without any injury, but should there be the least trace of pernitrate of silver remaining, the iodide of silver will become dark. It is a curious fact that good iodized paper is much improved by some hours exposure to sunshine: the picture obtained from paper so treated is much firmer than it otherwise would be. We owe this fact to the late Mr. Adamson of Edinburgh.

woolly, which will then print imperfectly; secondly, it is essential that the whole of the iodide should be removed, for if not, the amateur will find that the requisite degree of sensitiveness to light will not be obtained, for it will convert the excess of nitrate we add in order to make the paper sensitive, into iodide of silver, which, when pure, is absolutely insensible to light, as already stated. (§ 21.)

54. The following is another method of preparing iodized paper:—Dissolve about 20 grains of nitrate of silver in one ounce distilled water; add to this a solution of iodide of potassium, in small quantities, until it ceases to occasion a precipitate; pour off the supernatant liquid, and wash the precipitated iodide of silver two or three times in warm distilled water; allow the iodide to settle to the bottom of the vessel, and then drain off the water; now prepare a very *strong* solution of iodide of potassium, 50 grains to the ounce of distilled water, and add this to the iodide of silver until it is nearly all dissolved. Wash paper over with this solution, dry it perfectly by the fire, and then wash it well in common water, as directed for the usual iodized paper (§ 51.); as soon as the paper is dipped into the water, the iodide of silver, not being soluble in a *dilute* solution of iodide of potassium, is precipitated on the surface of the paper.

55. *Applying the Sensitive Mixture.*—This consists in the application to the iodized paper of a mixed solution of gallic acid and of nitrate of silver, called by Mr. Fox Talbot, Gallo-nitrate. It is prepared as follows:—Dissolve 100 grains of crystallized nitrate of silver, in two ounces of distilled water, to which add one-sixth of its volume of strong acetic acid (which will be two and two-thirds of a drachm); this solution should be kept in a bottle excluded from the light. Now make a saturated solution of gallic acid in cold distilled water, the quantity dissolved is very small. When some paper

is to be prepared, 5 drops of each should be mixed with 1 oz. of distilled water, and then poured upon the plate glass, having adjusted it by the set screws, so that the solution will not run off; the sheet of iodized paper should then be carefully applied to the wet surface, and the air bubbles gently pressed out by passing the finger over the back of the paper. As soon as the paper has ceased to curl upwards, it should be removed from the glass, *very gently* pressed between folds of blotting-paper—but only just enough to remove any shining patches of moisture on the surface—and then placed at once in the frame of the camera; it will be found to preserve its whiteness for ten or twelve hours, if carefully excluded from light. As a general rule, the longer we wish to keep paper after the sensitive solution is applied, the more the gallo-nitrate should be diluted; but when we wish for very sensitive paper, the dilution should not be more than three or four times the bulk of the mixed liquids. Another matter must be attended to carefully if we wish to obtain clean and clear pictures:—if the acetic acid we use be of the greatest possible strength, or the crystallizable acid, then the amount stated is the proper quantity; but if weaker, then we must add a larger quantity; for Mr. Cundell has pointed out (Phil. Mag. No. cxcii.) that one great cause of the failure of calotypists, is in having their paper blackened all over, or becoming of a dirty colour by the absence of the requisite quantity of this acid. The operator may, therefore, be sure that if his paper becomes discoloured when every care has been taken in the other parts of the process, he has not got enough acetic acid in the solution. The tendency of this acid appears to be, to keep the white parts of the picture clean and white, but too much destroys the sensitiveness of the paper.

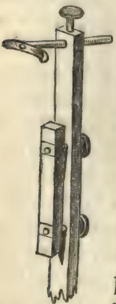
56. *Exposure in the Camera.*—The camera is to be placed upon some firm and steady support, and

pointed at the object we wish to represent. A clear and distinct focus is then to be obtained upon the ground glass, and the tube afterwards pushed in a certain distance to the chemical focus (§ 47.); the ground glass is then removed, and replaced by the frame containing the prepared paper, and the slide in front drawn up for a certain time, which depends upon the amount of light existing at the time, the size of the diaphragm in front of the lens, the sensitiveness of the paper, and the colour of the object to be copied, &c. All these matters the amateur must learn by experience, and with a few trials of his apparatus he will easily determine the time. It varies from about half a minute to five minutes; an exposure for a longer time seldom produces good results. The operator must bear in mind that any object of a yellow colour will take a much longer time than a white or blue, and when the light is yellow from clouds, or when near sunset, the picture will also take much longer to be produced. Generally, in views or buildings, a much better effect is produced when the sun shines on the object for a few seconds, as we are about to withdraw the paper; it sharpens and gives a much greater intensity to the lights, whilst, if there had been sunshine during the whole of the exposure, the shadows would have been very heavy.

57. *Portraits.*—In copying "the human face divine," two or three hints may not be unacceptable to the amateur. The sitter should be placed in an easy, natural position, and remain perfectly still during the operation. A very ludicrous effect is often given from an inattention to this, for it is obvious, if a person assumes two or three positions during the exposure of the paper, there will be a corresponding number of images impressed, and we may thus have a representation of one or two additional noses, fingers, or eyes, or the nose or eye may have a greater breadth, or be consi-

derably elongated; to avoid this, a rest for the head should be made use of, one form of which is represented (Fig. 11.); this is to be attached firmly to the

Fig. 11.



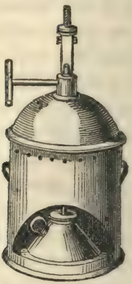
back of the chair, and the person allowed to assume the desired position; the rest should then be adjusted so that the arm having the curved piece of brass attached just touches the back of the head; this will keep it sufficiently still for all the minute markings to be very accurately copied. In order to operate with success, the model should be well illuminated, but at the same time care should be taken to avoid the direct rays of the sun; for this purpose a sort of canopy should be placed over the head, made of blue calico, so that the shade may fall beyond the feet; this will also prevent too much light falling on the forehead and the top of the shoulders; a quantity of light falling directly from above has the disadvantage of not shewing the eyes with distinctness, the shadows from the eyebrows and forehead falling on them. With respect to the proper backgrounds, these depend upon the taste of the operator: some paint a landscape, library, or balcony roughly, and place it behind the sitter; and they look very well for a full length portrait, or a group: for a plain background, an old blanket gives a very even and uniform tint. As a general rule, the camera should be placed about the height of the eyes; by this means, the upper or intellectual part of the head will be slightly enlarged, the eyes may be directed towards the camera.

58. *Views.*—The operator must be very careful, when directing the camera to a building, &c. that it should be *perfectly horizontal*; for if it is pointed upwards, so as to take in the whole of the object,

the picture will have a very bad effect, for the building will appear in the picture as if falling, and none of the perpendicular lines will be erect. Some have recommended that the operator should endeavour to have the camera placed at about one-third of the height of the building, but we think pictures have a more pleasing and natural effect if taken from the street, at about the height of the eye, so as to get the same angles in the picture we are accustomed to, in viewing any object. It is generally better to have the camera at about the *distance* of *double the height* of the object; of course, it must be left to the taste and management of the operator, as to the contrasts, &c. in the picture. The object upon which we place the most importance, and of which we desire the clearest representation, on this we should adjust the focus of the camera; but should the landscape embrace various objects, at different distances, it will be necessary to use a very small opening in front of the lens, otherwise only one or two objects will be distinctly in focus, and all the rest indistinct.

59. *Developing the Picture.*—When the paper has been exposed in the camera the requisite time, there is, to all appearances, seldom any impression, but the picture exists, though in a latent state. In order to render it visible, Mr. Fox Talbot directs that the paper should be again washed over with a solution of the gallo-nitrate of silver, and then exposed to a gentle heat. The best method of applying this gallo-nitrate, is to pour it, as before directed (§ 55.), upon the piece of plate glass (taking care that it is thoroughly clean), and then apply the paper to the surface until it is moderately wet; any air bubbles should be pressed out, by passing the finger over it as before mentioned. The paper should then be held in front of the jet of steam, which should be allowed to act equally all over the paper, when the picture will slowly develop

Fig. 12.



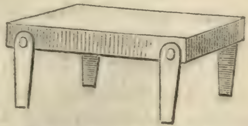
itself. Fig. 12. represents a convenient apparatus for the purpose. Should any part of the picture not appear sufficiently distinct, the jet of steam may be allowed to play upon it for a short time longer than the other parts. The paper should *not be allowed to become dry* in this process, otherwise the heat will embrown it, but it may be re-wetted with the gallo-nitrate, and again exposed to heat. A very simple and very effectual plan is to develop the picture by means of the steam and heat arising from a basin of hot water—the picture should be held horizontally, and moved about over the steam. Some have recommended a dry heat, viz., by a vessel heated with hot water, but this plan is very apt to embrown the picture, the moisture being so soon evaporated, whereas with the steam, a considerable amount of water is condensed, and the paper is therefore kept moist. During the summer months it is not necessary to use any *heat* in developing the picture; it may be placed in a dark drawer, and left until sufficiently brought out. After the picture has attained its greatest intensity, it should be immediately submitted to the operation of fixing, as described at § 63.

60. The following deviation from this last process answers extremely well when the paper is to be used and the image brought out immediately; the pictures obtained by its means are generally very clean, and the light parts very white; for portraits, and where great quickness is required, we have found it excellent.

Obtain some paper known to photographers by the watermark "Canson Frères;" immerse pieces of this, cut to the proper size, in a solution of iodide of potas-

sium containing thirty grains to one ounce of water, suspend it by one corner until dry, when it will assume a dark colour, from a slight decomposition of the iodide of potassium and the liberation of a little free iodine. The paper in this stage of the preparation may be kept for any period; when required for use it should be floated upon a solution of aceto-nitrate of silver of the strength indicated (§ *55.*); the paper will gradually lose its dark colour, and become of a beautiful primrose. When the last traces of the bluish colour have disappeared, it is very sensitive to light, and ought to be used at once in its wet state; it must not be touched by blotting paper or enclosed between glass. The camera back should be provided with a glass plate, which must be wetted with distilled water, and the back of the prepared paper laid upon it; the paper will adhere perfectly for some time. After the exposure the picture should be developed by solution of gallic acid alone; this is best applied by means of a glass plate (§ *55*). Should the image be long in developing it may be hastened by exposure to a steam heat in the glass plate, and gallic acid solution may be warmed by laying it on the hot water apparatus shown at fig. 13. After it is sufficiently brought out it may be fixed by hyposulphite in the ordinary way (§ 63). The image when fixed ought to be intensely black and white; should the dark parts of the picture be of a red colour, it may be known that the exposure in the camera has been too prolonged; if the objects in half tint are not seen, a longer time ought to have been given. It will be observed that in this process the solutions of nitrate of silver and of gallic acid are not mixed before application to the paper, as in Mr. Talbot's process; we therefore can use a brush for

Fig. 13.



applying the solutions, which is sometimes an advantage; of course, separate brushes must be used for the nitrate of silver and for the gallic acid. In preparing calotype paper, too much care cannot be taken, not only to prevent the daylight falling on it, but also to exclude, if possible, the strong glare of a candle or lamp. The candle should be removed some distance from the paper, or a yellow screen should be placed around it. This must be particularly attended to when the paper is intended to be kept some time after the sensitive mixture has been applied, for the slightest impression of light will in a little time develop itself strongly; it will make its appearance when the picture is brought out, giving the light parts a dirty appearance, or, very probably, the paper will blacken all over.

61. *Albumenized Paper for Negatives* —M. Blanquart Evrard has lately described a method of obtaining the photograph on paper prepared with albumen. We give his account: — "The impressions obtained by means of the following preparations are admirable; though not so defined as those on glass (§ 79.), yet they are more beautiful, as the outline is less harsh, and they possess more harmony and softness." We consider this to be quite a triumph for those who exercise themselves in the photographic art. Beat into a froth the whites of eggs, to which a saturated solution of iodide of potassium has been added in the proportion of thirty drops for each egg. Let the mixture stand until the froth returns into a liquid state; filter through clean muslin, and collect the albumen in a large flat vessel. On this lay the paper to be prepared, and allow it to remain there some minutes; when it has imbibed the albumen, lift it up by one of its corners, let it drain, and lastly dry it by suspending it with pins to a line or cord across the room. It is rendered sensitive as follows:—Cover a piece of glass with aceto-nitrate of silver, composed of one part

nitrate of silver, two parts of glacial acetic acid, and ten of distilled water; on this solution the albumenized paper should be carefully laid; beginning at one corner of the paper, it should be depressed on the solution by an even regular motion, not stopping a moment, otherwise there will be a stain. After the paper has become quite transparent, which may be ascertained by lifting it up, and looking through it at the candle, it must be dried between folds of blotting paper, and placed between the glasses of the camera frame. It is developed by a saturated solution of gallic acid, as in the preceding process; it will be found, however, that the exposure in the camera will require to be four or five times longer.

62. Mr. Colls, a very successful photographer, has given the following formula for producing camera photographs:—

10 grains nitrate silver,
1 ounce distilled water,
2 drachms crystallized acetic acid.

A small quantity of this should be mixed when required for use with an equal volume of saturated solution of gallic acid, and washed over the iodized paper with a brush, and the excess absorbed by bibulous paper. After exposure in the camera the picture is brought out by another wash of the same mixture. It will be some time developing, but may be hastened by being held over hot water.

63. *Fixing the Picture.*—As soon as the picture is sufficiently developed the gallo-nitrate should be washed off as quickly as possible, otherwise the paper will blacken all over, and the water used for washing should be once or twice renewed; it may remain in water about ten minutes, the proof should then be taken out, pressed between folds of clean blotting paper, and placed in a strong solution of hyposulphite of soda. As soon as the *whole of the yellow iodide* of

silver has been dissolved it should be taken out, well washed in abundance of common water, and to insure the removal of the whole of the hyposulphite of silver, left in a quantity of water for some hours, and then, upon being dried with blotting paper, it will be found to be very perfectly fixed. If it is not convenient to operate at once with the hyposulphite of soda, which process requires a great quantity of water and long soaking, it may be fixed for a few days very well, until the operator has time to use the hyposulphite, by a single wash with a solution of bromide of potassium, containing 10 grains to the ounce of water; it should then be dipped in water and dried by blotting paper, between the folds of which it should be kept until the hyposulphite can be applied.

64. *Obtaining the Positive Photograph.*—The picture just described, as being obtained in the camera, is a negative picture, similar to those we have mentioned in the description of the common photographic papers. (§ 30.) It is therefore necessary that a positive picture, or one with the lights and shades as they occur in nature, should be obtained; this can be produced very quickly on the calotype paper, but it is unadvisable, as the tone of the picture is not so pleasant as that obtained by the common photographic processes. (§ 20.) The ammonio-nitrate paper is decidedly the best. The negative calotype picture should be laid, with its face downwards, upon a piece of this paper, and secured at two of the corners by morsels of wafer, then placed in the pressure frame, Fig. 4. and exposed to light, until the necessary degree of intensity in the positive picture is produced. This can be readily ascertained by taking it out of the frame, and raising it gently, so as not to disturb its position, or draw it apart from the wafers; the rest of the process with the positive picture being precisely the same as at § 34.

65. Mr. Fox Talbot has described a plan by which

the tone of the positive picture is altered considerably. He directs that, after removal from the light, it should be placed in a weak solution of iodide of potassium. This will convert the whole of the free nitrate of silver into the yellow iodide of silver. It should then be immersed in a boiling solution of the hyposulphite of soda,—the yellow colour will be removed from the lights, and a very peculiar tone left on the picture. This is a very perfect method of fixing, the photograph seldom becoming dark, as is the case sometimes with other plans.

66. This process has also been applied by the same gentleman to fix the negative photographs; the negative picture should be immersed in a hot solution of the hyposulphite until the yellow colour disappears from the iodized paper, and then washed as usual. This is stated by Mr. Talbot to produce better positive pictures, but in our hands it has not proved successful, the hot hyposulphite seems to injure the picture considerably. It does not appear to us to have any advantage over the method we give at § 56. for by that process the yellow iodide of silver may be quite removed from the paper without any fear of damaging the photograph.

67. The calotype process just described is exquisitely sensitive, very beautiful impressions from prints, leaves, ferns, and pieces of lace, may be produced in a few minutes by exposure to moonlight, a candle, or gas light, but for producing the same effect in sunshine a fraction of a second is sufficient. Some operators render the negative pictures transparent, this is sometimes an advantage when we wish to print very quickly; it may be done as described § 33.

68. Sir D. Brewster has proposed a modification of this method of obtaining positive photographs. He states that the present mode gives a roughness of shade which destroys the softness of the picture.

To obviate this he interposes a sheet of white paper without water-mark, and of uniform texture. The diffusion of the light thus occasioned shades off, as it were, all the sharp lines and points, and gives a higher degree of softness to the picture. Two, or even three sheets may be interposed in strong sun-light. A similar effect may be obtained in a less degree by placing the back of the negative upon the positive paper, so as to cause the light to traverse the thickness of the negative, and this may be combined with one or more sheets of clean paper; but it will be appropriate only for portraits, and has the advantage (sometimes required) of making the individual look another way. "To those," adds Sir David, "who see the experiments above described for the first time, the effect is almost magical; and when the negative is removed, we see only a blank sheet of white paper, and our surprise is very great when, upon lifting this sheet, we discover beneath it a perfect picture, which seems, as it were, to have passed through the opaque and impervious screen."

The calotype process has been much simplified by Mr. Hunt, to whom we are indebted for the greater number of processes on paper at present known, and whose valuable researches on the chemical effects of light have added so greatly to our knowledge of that mysterious agent.

69. Mr. Hunt has shown that the action of light on nearly all the salts of silver may be hastened, and the effects developed by gallic acid, or other reducing agents, and he has given several formulæ for producing pictures. We supply one which we have found the best, but the principle is the same in all. An insoluble salt of silver is formed in the paper having a slight excess of the nitrate, this is exposed to light, and then brought out by a solution of gallic acid, or proto-sulphate of iron. The following Mr. Hunt calls

FLUOROTYPE.

70. A sheet of paper is to be washed, first, with a solution of bromide of potassium, and then with the fluate of soda, or, which will be found the better plan, the two salts may be united. The strength should be as follows:—

Bromide of potassium,		20 grains.
Distilled water,	. .	1 fluid ounce.
Fluate of soda,	. .	5 grains.
Distilled water,	. .	1 fluid ounce.

Mix a small quantity of these solutions together when the papers are to be prepared, and wash them once over with the mixture, and when dry, apply a solution of nitrate of silver, sixty grains to the ounce of water. These papers keep for some weeks without injury, and become impressed with good images in half a minute in the camera. The impression is not sufficiently strong when removed from the camera for producing positive pictures, but may be rendered so by a secondary process.

71. The photograph should first be soaked in water for a few minutes, and then placed upon a slab of porcelain, and a weak solution of the proto-sulphate of iron brushed over it; the picture immediately acquires great intensity, and should then be stopped directly, or the blackening will extend all over the paper; it may be fixed by being soaked in water, then dipped into a solution of hypo-sulphite of soda, and again soaked in water as in the other processes.*

72. We find it is better to add to the proto-sulphate of iron a little acetic or sulphuric acid: this will be found to prevent the darkening of the lights of the picture to a great extent; it will also be better not to prepare

* For further particulars of this and other very beautiful photographic processes, see Mr. Robert Hunt's valuable "Researches on Light."

the paper long before it is required for use, this being one reason why the picture often becomes dusky on application of the proto-sulphate.

Reasoning upon the principles that the action of light is to reduce the salts of silver in the paper to the metallic state, and that any substance which would reduce silver would also quicken the action of light, we were led to the following experiment: The proto-chloride of tin possesses the property of reducing the salts both of silver and of gold; a paper was prepared with the bromide of silver, and previously to exposing it to light, it was washed over with a very weak solution of the chloride of tin; the action of light upon the paper was exceedingly energetic; it was almost instantaneously blackened, and a copy of a print was obtained in a few seconds; this was performed last summer. We have lately tried once or twice to repeat the experiment, but without success; the paper being blackened in the dark spontaneously. We hope, however, to perfect a process which gives so much promise.

FERROTYPE OR ENERGIATYPE.

73. Mr. Hunt some little time ago announced a process he then called the Energiatype, from an opinion of his, that the effects produced were not by light, but resulted from a peculiar principle he denominated Energia; he has, however, since altered the name to Ferrotype, which includes all the processes in which proto-sulphate of iron is used as a reducing agent. The original process was as follows: — a solution is prepared by dissolving two drachms of succinic acid, and five grains of common salt, in one fluid drachm and a half of distilled water, having previously added half a drachm of mucilage of gum arabic; this is applied to the paper, and when dry, is to be washed over with a solution of nitrate of silver, containing sixty grains to the ounce of water;

it is allowed to dry in the dark, after which it is fit for use. It may be preserved in a portfolio, and placed in the camera when wanted. The time necessary for exposure varies from two to eight minutes, but like the calotype no image is at first visible; in order to bring out the latent picture, it is necessary to wash it with a saturated solution of proto-sulphate of iron, to which has been added two drachms and a half of mucilage of gum arabic; we find it is an improvement in this process as well as in the Fluorotype, and, indeed, in all cases when the proto-sulphate of iron is used, to add to it a little acetic acid (§ 61).

74. It is not essential to use the succinate of silver, for Mr. Hunt finds that the picture may be produced either with the benzoate, the bromide, the iodide, the arseniate, or, indeed, nearly any one of the salts of silver. The proto-sulphate of iron has this advantage, that pictures may be produced much more quickly by its means than by any other method; when used instead of gallic acid in developing an ordinary calotype picture, the quickness is extraordinary, and engravings, &c. may be copied absolutely instantaneously.

75. Mr. Hunt has modified this process in a very ingenious way; he has taken advantage of the property possessed by the oils of cassia and of cloves in precipitating metallic silver, as in Drayton's process for silvering mirrors, but he finds that the silver will be precipitated more readily upon those parts where the light has acted. The following is the process:—

The paper, after having been submitted to the influence of light, is immersed in spirits of wine containing in solution a small quantity of the essential oils of cassia and of cloves, and as soon as the spirit has penetrated the paper, it is to be pressed between folds of blotting paper previously saturated with the same solution, and then pressed together between two pieces of plate glass; in the course of an hour or two

the picture will be developed very beautifully, and may be fixed in the ordinary way.

CHROMOTYPE.

76. This is another process for which we are also indebted to Mr. Hunt, and it has this advantage, that it is a positive process; that is, a copy of an engraving is produced at once, with the lights and shades correct; it is also one of the most simple and easily managed, and the pictures produced are very beautiful. The process was made known at the Meeting of the British Association, August 1843. We give Mr. Hunt's description of this process.

One drachm of sulphate of copper is dissolved in half an ounce of distilled water, to which is added half an ounce of a saturated solution of bichromate of potash; this solution is applied to the surface of the paper, and, when dry, it is fit for use, and may be kept for any length of time without spoiling. When exposed to sunshine, the first change is to a dull brown, and if checked in this stage of the process we get a negative picture, but if the action of the light is continued, the browning gives way, and we have a positive yellow picture on a white ground. In either case, if the paper, when removed from the sunshine, is washed over with a solution of nitrate of silver, a very beautiful positive picture results. In practice, it will be found advantageous to allow the bleaching action to go on to some extent; the picture resulting from this will be clearer and more defined than that which is procured when the action is checked at the brown stage. To fix these pictures it is necessary to remove the nitrate of silver, which is done by washing in *pure* water; if the water contains any muriates the picture suffers, and long soaking in such water entirely destroys it, or if a few grains of common salt are added to the water the apparent destruction is very rapid. The picture is, how-

ever, capable of restoration; all that is necessary being to expose it to sunshine for a quarter of an hour, when it revives; but instead of being of a red colour, it becomes lilac, the shades of colour depending upon the quantity of salt used to decompose the chromate of silver which forms the shadow parts of the picture. We find that, by substituting sulphate of *nickel* for the sulphate of *copper*, the paper is more sensitive, and is more clearly developed by the nitrate of silver.

77. Mr. Hunt has since modified this process—we give his account: "A neutral solution of the chloride of gold is mixed with an equal quantity of the solution of bichromate of potash. Paper washed with this solution, and exposed to light, speedily changes, first to a deep brown, and ultimately to a bluish-black. If an engraving is superposed, we have a negative copy, blue or brown, upon a yellow ground. If this photograph is placed in clean water, and allowed to remain in it for some hours, very singular changes take place. The yellow salt is all dissolved out, and those parts of the paper left beautifully white. All the dark portions of the paper become more decided in their character, and, according as the solarization has been prolonged or otherwise, or the light has been more or less intense, we have either crimson, blue, brown, or deep black negative photographs."

78. A process with the bichromate of potash has also been announced by Mr. Mungo Ponton. Paper should be soaked in a saturated solution of the bichromate of potash, and then exposed to sunshine; a delicate buff coloured negative picture upon a yellow ground will be the result. To fix these pictures, all that is necessary is to soak them in common water, when the yellow colour will disappear, and they will be perfectly white,—this is a simple and easy process, the *rationale* of which appears to be this:—Bichromate of potash consists of chromic acid and potash; under the

influence of light, the starch in the size of the paper and the chromic acid react upon one another, and it is very probable that the acid is partially reduced, for, with paper having very little size, the bichromate bears a much longer exposure. A knowledge of these facts has led to a pretty modification of this process by M. Edmund Becquerel: he directs that paper should be steeped, in a weak solution of iodine in alcohol and then copiously washed in water, it will then assume a beautiful blue tint; if this tint be uniform the paper is deemed proper for the experiment, otherwise the operator must size it himself with starch. It is afterwards to be steeped in accordance with Mr. Ponton's method, in a concentrated solution of bichromate of potash, and the superfluous moisture removed by bibulous paper and dried; it is now ready for exposure to light; in order to copy an engraving it will require a time varying from one minute to fifteen according to the thickness of the paper of the engraving and the intensity of the light. After the exposure, wash the paper well and when dry steep it in a weak alcoholic solution of iodine, after it has remained some time wash it in water and then dry it between the folds of blotting paper, but not before the fire, for the compound of iodine and starch is discoloured at about 212° Fahrenheit. If it is thought that the copy is not sufficiently brought out, repeat the immersion several times; by this means you may obtain any degree of intensity of tone that you may wish the picture to have. In this process the chromic acid seizes upon the starch over those parts which have been exposed to light. Now, as starch possesses the property of forming with iodine a combination of a very fine blue, it is evident that on those parts of the paper which have not been impressed by the solar rays, the starch will not have combined with the chromic acid; the iodine will therefore form the blue iodide of starch, and thus represent shade by shade.

CHRYSOTYPE.

79. This is a process discovered by Sir John Herschel, in which iron and gold are used as photogenic materials Good paper is to be washed with a solution of the ammonio-citrate of iron, dried, and afterwards washed over with a solution of ferrosesqui-cyanuret of potassium. This paper should be dried in a perfectly dark room, when it will be ready for use in the camera. After it has been exposed a short time, the picture may be developed by washing it with a neutral solution of gold, of such a strength as to appear of the colour of sherry wine; the image instantly becomes visible, and may be fixed by being well washed in water, dried by blotting paper, and then again washed in a weak solution of the iodide of potassium. Should the picture not have been well washed previously to the application of the iodide of potassium, the lights will become discoloured, but will speedily whiten again spontaneously.

CYANOTYPE.

80. Sir John Herschel is also the originator of this process, or rather a number of processes, for it includes all pictures taken with salts of iron, particularly when in combination with cyanogen. Paper is washed over with a moderately strong solution of the ammonio-citrate of iron, and exposed in the ordinary way until a faint negative picture makes its appearance. A saturated solution of the common ferro-prussiate of potash, in which is dissolved a little gum arabic, is then to be rapidly passed over the paper, when the negative picture disappears, and is replaced by a blue one, having a green ground. This picture requires no fixing.

81. Another method, which requires a longer exposure to the sunshine, possesses this advantage—the lights of the picture are white, and the shadows of a beautiful blue. The following is the mode of preparation:—Wash paper over with a solution of nitrate of mercury, and, when dry, with a saturated solution of sesqui-cyanuret of potassium. It is now ready for exposure, which should be continued until the required degree of intensity in the colour is produced. The picture may be fixed by soaking in cold water, to which a little alum has been added.

82. A very interesting and curious process was discovered by Sir John Herschel, by which latent pictures can be produced, which are capable of being developed by the breath, or by a moist atmosphere. If solution of nitrate of silver, specific gravity 1·200, be added to ferro-tartaric acid, specific gravity 1·023, a precipitate falls, which may be again nearly redissolved by a gentle heat; a yellow liquid is obtained, in which further addition of the nitrate causes no turbidness. When the total quantity of the nitrate solution amounts to one-half the bulk of the ferro-tartaric acid, it is enough. The liquid so prepared does not alter in the dark. The paper is to be spread over with this solution and exposed wet to sunshine (but partially shaded); for a few seconds no impression seems to be made, but by degrees, although withdrawn from the light, it developes itself spontaneously, and at length becomes very intense. But if the paper be thoroughly dried in the dark, it possesses the singular property of receiving a dormant or invisible picture, to produce which (if it be, for instance, an engraving which is to be copied) from thirty seconds to a minute's exposure to sunshine is requisite. It should not be continued longer than that time, as not only the ultimate effect is less striking, but a picture begins to be visibly developed, which darkens spon-

taneously after it is withdrawn. But if the exposure be discontinued before this effect is produced, an invisible impression is the result; to develop which, it is only necessary to breathe upon it, when it very speedily acquires an extraordinary intensity and sharpness, as if by magic. Instead of the breath, it may be subected to the regulated action of aqueous vapour, by laying it in a blotting-paper book, of which some of the outer leaves have been damped by holding them over warm water.

POSITIVE CALOTYPE.

83. At the second Meeting, at York, of the British Association, Professor Grove described a process by which positive pictures could be taken at once, without the trouble of having to make a negative in the first instance. Ordinary calotype paper is darkened till it assumes a deep brown colour, almost amounting to black; it is then redipped in the ordinary solution of iodide of potassium, and dried. When required for use, it is drawn over diluted nitric acid, one part acid, and two and a half parts water. In this state, those parts exposed to light are rapidly bleached, while the parts not exposed remain unchanged. It is fixed by washing in water, and subsequently in hyposulphite of soda, or bromide of potassium.

Mr. Grove likewise described on the same occasion another process which promises, when carried out, to be of great utility. It is the conversion of a negative calotype into a positive one, and was thus stated: Let an ordinary calotype image or portrait be taken in the camera, and developed by gallic acid; then drawn over iodide of potassium and dilute nitric acid, and exposed to full sunshine; while bleaching the dark parts, the

light is redarkening the newly precipitated iodide in the lighter portions, and thus the negative picture is converted into a positive one.

CATALISOTYPE.

84. The above name has been given to a process described by Dr. Wood:—The paper to be prepared is steeped in distilled water, to which has been added hydrochloric acid in the proportion of two drops of the former to three ounces of the latter; when well soaked, the moisture is to be lightly absorbed by blotting paper, and washed over with a mixture of half a drachm of syrup of ioduret of iron, in two and a half drachms of water, into which one or two drops of a solution of iodine may be dropped. It is now to be dried with bibulous paper, and washed over evenly with a solution of nitrate of silver, twelve grains of the salt to the ounce of water. It is now ready for the camera, the time of exposure varying from a second to half a minute, according to the degree of light. When removed from the camera no picture is visible, but if left in the dark it gradually developes itself, and ultimately becomes extremely perfect. It is fixed by washing first in water, and afterwards in a solution of bromide of potassium (twenty grains to an ounce), after which it must be again carefully washed and dried. Mr. Mayall has informed us, that instead of using the syrup of ioduret of iron, it is better to use the ioduret of iron dissolved in gum-water: we have seen some very good pictures produced by him with this modification of the Catalisotype.

85. A process has been proposed by M. Gaudin, (which appears to be a modification of one mentioned by Dr. Schafhaeutl and of Mr. Hunt's Ferro-

type): — The paper is exposed for a minute in the vapour of hydrochloric acid, after which a nearly saturated solution of nitrate of silver is to be brushed over its surface, and allowed to dry. The dry sheet is placed in the camera in the dark. On removal no trace of the image will be visible; but upon wetting the paper with a nearly saturated solution of *sulphate of iron*, slightly acidified by the addition of a few drops of sulphuric acid, the picture is immediately developed. The time necessary for exposure in the camera is much about the same as for the calotype. To fix the picture, which is a negative one, it must be first washed in common, and subsequently in distilled water, to which has been added ten per cent. of caustic ammonia. This is stated to be a good paper for obtaining positive pictures from negative ones; for which purpose, however, the sulphate of iron need not be used.

PHOTOGRAPHY ON GLASS.

86. Some time ago, Sir John Herschel, in his experiments with photographic agents, found that glass plates might be made use of with advantage for supporting the film of sensitive matter; his method of proceeding was to pour into a deep vessel a solution of iodide of potassium extremely diluted, to add to a very small quantity of the nitrate of silver so as to obtain a liquid only slightly milky; at the bottom of this vessel, he laid horizontally a glass plate, and allowed the iodide to become very slowly deposited; the liquid was then carefully drawn off by means of a syphon, and the last portions by a little tow or blotting paper: when this was dry, he had a pure and uniform film of the iodide of silver. This plate was then placed

at a very small inclination, and a weak solution of the nitrate of silver poured upon its upper edge; it flowed over the whole surface, and was allowed to drain off at one of the corners: it was then put in the camera in the same manner as we should a Daguerreotype plate; was moderately sensitive, and darkened to a good black in a short time.

Sir John Herschel observes, that "if we wash pictures obtained in this way with the hyposulphite of soda they disappear, but this is only whilst they are wet; for, upon washing with pure water and drying, they are restored, and assume when laid on a black ground much the appearance of a Daguerreotype, and still more so, when smoked at the back, the silvered portions reflecting most light, so that the character is changed from a negative to a positive drawing. To obtain delicate pictures the plate must be exposed wet, and when withdrawn should be immediately plunged into water, that the nitrate of silver which is liable to crystallize may be abstracted." This process, however, is rather troublesome, and the chloride or iodide is very liable to come off the plate in the various washings to which it is necessary to subject it; neither are the shades sufficiently intense to obtain a good positive picture. We have made many experiments on this subject, and have lately produced several negatives on glass which appear very promising. By one of the following processes very good results may be obtained:—

87. *First Process.*—Beat for about ten minutes the whites of two or three eggs, then cover up the vessel, and allow the froth which is produced to resume the fluid state;* pour a little of this liquid upon a piece of clean glass (previously adjusted by set screws to a perfectly horizontal position) and

* M. Niepce de St. Victor first suggested the use of albumen for making a film on a glass plate on which to apply the sensitive coating.

spread it evenly over the surface, using the edge of a piece of smooth and clean writing paper for that purpose; allow this layer of liquid to get quite dry, and then submit it to a heat of about 212° for two or three minutes: now prepare a solution of nitrate of silver containing 200 grains to 4 ounces of distilled water; pour this into a shallow dish, and then suddenly plunge the plate of glass into it; the solution should run over the whole surface at once, otherwise the coating will not be uniform: take the plate out and rinse it for a second or two in a basin of distilled water; and then put it into a dish containing a solution of iodide of potassium 10 grains to 1 ounce of water, let it remain for a minute, and then again wash it well in distilled water for about ten minutes; the glass must then be taken out, suspended by one corner, and allowed to dry; a number of glasses may be thus prepared and kept until required for use. To render the plate sensitive it is immersed into a solution of gallo nitrate of silver prepared as described for the ordinary calotype process at § 55; this should be diluted about twenty times; let the glass remain in the dish about three or four seconds, then take it out and shake off the superfluous liquid; it is now very sensitive to light, and may be used either at once or kept without spoiling for ten or twelve hours. After the picture has been impressed in the camera it may be brought out by pouring over it gallo nitrate of silver (§ 59); as soon as it is fully developed it should be washed in a little water, and then placed in a solution of hypo-sulphite of soda (§ 63) for about ten minutes, and afterwards washed in a quantity of common water and dried in a warm place.

88. Beautiful positives may be obtained from these plates, having a degree of delicacy which cannot be attained in any other way; the process is precisely the same as that from a paper negative (§ 64.); but the

positive picture may be produced upon another piece of glass prepared in the same way.

89. *Second Process.*—Obtain some very clear and good isinglass, pour on it a little hot water, so as to produce a thick jelly; while still warm and fluid, mix with it a few drops of a strong solution of the proto-iodide of iron, pour a little of this mixture over a piece of glass, and drain off the excess at one corner; allow this to get perfectly dry and hard, then suddenly immerse it in a solution of nitrate of silver, containing 100 grains, in two ounces of distilled water; it is now sensitive to the action of light, and should be at once placed in the camera. A very slight picture will, perhaps, only be visible; but it may be fully developed by putting it into a solution of the proto-acetate of iron, containing a small excess of acetic acid. As soon as the picture is fully developed, it should be rinsed in a little water, and fixed with hyposulphite of soda, as in the preceding process.

90. We may, in place of the gelatine (isinglass), employ a number of other substances to form an adherent film upon the glass. The following are a few of those we have experimented with, and found to answer moderately well:—Vegetable gluten, dissolved in acetic acid, forms a very tenacious coating, and difficult to remove. Collodion (gun cotton dissolved in æther)—the spirit of wine varnishes—a mixture of albumen and gelatine, in equal proportions, applied as directed for albumen alone in the first process, and then immersed in an infusion of oak bark. Several of the gums, starch, casein from milk, vegetable albumen, &c. The method of applying the solutions may be varied in a number of ways, and opens a wide field for experiment. When starch is used as a film upon the glass, the iodine and bromine requisite for converting the nitrate of silver into the iodide or bromide may be advantageously applied in the state of

vapour as in the Daguerreotype process; if a plate of glass, covered with starch, be exposed to the iodine vapour, it will gradually assume a fine violet colour from the formation of iodide of starch. When immersed in the nitrate of silver, the violet colour disappears, and is replaced by the pale primrose of the iodide of silver. If the starch plate is exposed to bromine, a red colour is produced, which, on immersion in the nitrate solution, disappears, and the white bromide of silver is produced.

91. Since the foregoing paragraphs were published in January 1850,* a patent has been granted for certain improvements in photography; many of which, however, were well known and practised by amateurs of the art, previous to the date of the patent;† amongst other things claimed is the production of positive pictures on glass. Now we have seen that Sir John Herschel, in his experiments on glass plates made some years ago (§ 86), mentions that the negative photogragh is also a positive one, according as it is seen by reflected or transmitted light; and we may confidently say that any one who had experimented with the glass process prior to this new patent, must have observed that in nearly every instance the negative is also a positive picture, particularly if it has been a long time in the developing mixture (described § 86).

92. In paragraph 90, we described a photographic process on glass, in which the fumes of iodine are used for impregnating the coated glass; this was published January 1850. In June, 1850, Mr. Malone, in a letter to the *Athenæum*, and in his patent specification, described the application of iodine to all photographic surfaces, excepting metallic plates, as his discovery; now this has

* In this edition we have purposely kept the paragraphs 78 to 82 as they were in the edition published January 1850.

† Vide specification of patent granted to Messrs. Talbot and Malone for certain improvements in Photography. June 1850.

been known and used for some years. Mr. Hunt, in a work written by him, and published in 1841,* mentions that paper may be usefully impregnated with iodine by exposure to its vapour. In a process by Dr. Schafhaeutl, communicated to the British Association, he advises the use of the fumes of muriatic acid for preparing the paper. The vapour of iodine has also been used both by ourselves and Mr. Cundell, and had been mentioned to most of the London photographers some time prior to the date of the patent. All these facts may appear to be trifling; but it is not for their importance we take this trouble to mention and insist on the date and the authors of their discovery, but we wish the principle to be more generally recognized, (and in these days of *patent* inventions, *patentees* are so apt to lose sight of it) that scientific matters freely given to the world become the general property of the public, and no system of patent laws should sanction the appropriation of them by private individuals.

93. *Methods of rendering the glass more sensitive.*—It has been mentioned by M. Blanquart Evrard that the fluoride of silver forms a very sensitive coating for the glass plates. This substance has already been proposed as a photographic material. It was used very successfully by Mr. Robert Hunt in his fluorotype on paper (§ 70), and was suggested by Sir John Herschel for glass upwards of ten years ago. Its mode of application to the albumenized plate is as follows:—Take the whites of several eggs, and dilute with an equal bulk of water; to every ounce of this albumen, add fifteen grains of iodine of potassium, and five grains of fluoride of potassium or sodium (fluate of soda); after beating up into a froth, put it into a large glass funnel, and receive the clear liquid in a lipped test glass

* A popular treatise on the Art of Photography, by Robert Hunt. Griffin and Co., Glasgow.

Fig. 14.

(Fig. 14): now clean a plate of glass thoroughly, first with a little alkali, and subsequently with clean water and a piece of old worn silk; the glass should be constantly breathed upon during the latter part of the cleaning process; otherwise it will have a tendency to become electrical and attract particles of dust: for this reason we advise the silk should also be slightly damp; after the plate has been thoroughly cleansed, pour on as much albumen as the glass will hold, move it about slightly until perfectly covered, then pour off the excess at one corner, if sufficient of the albumen be used, all the dust and small particles will rise to the surface, and float off when the excess of liquid runs from it; allow the plate to drain for a moment or two, removing the drops by passing the fingers along the edge; now lay it in an horizontal position in a hot air chamber, (a common oven does pretty well, but the plate is apt to get spotted with dust on opening and shutting the door, from its proximity to the fire); as soon as it is quite dry it may be preserved for the next operation, that of rendering it sensitive to light. It may be here observed, that it is not necessary to expose it to a high temperature, for the albuminous film is not coagulated or rendered any more insoluble: by this means a temperature sufficient to drive off the water is all that is necessary.* When we wish to take a picture, the prepared plate should be plunged suddenly into a solution of aceto-nitrate of silver, contain-

* It is curious that we may expose albumen when in a thin film to any temperature without coagulation; this fact has not been noticed, and in directions for producing glass pictures, we constantly find it stated that it is necessary to expose a plate to a heat of 212°, under the impression that it will coagulate the albumen and render it less soluble.

ing eighty grains of nitrate of silver in one ounce of distilled water, two drachms of acetic acid being subsequently added; after a second or two it must be taken out of the solution, and washed in distilled water, as much of the water shaken off as possible, the back dried with bibulous paper and then placed in the camera. The image may be developed by pouring over it a mixture of equal parts of the ordinary aceto nitrate of silver and solution of gallic acid. It will sometimes be one or two hours before it becomes sufficiently intense, and is fixed in the usual way.

The method we have described is only applicable when the glass is used immediately; if we wish to keep it for any time after it is made sensitive, it should be allowed to get perfectly dry (which will take some hours) before it is placed in the camera slide; this is sometimes troublesome and inconvenient. We have found that the drying is much expedited by passing the plate into alcohol after it has been washed in water; the great affinity strong alcohol has for water dries the plate in a few minutes, as the alcohol takes but a short time to evaporate.*

94. The fluoride of potassium may also be used when the plate has been previously impregnated with the iodide of silver as described (§ 79). In exciting this plate we should wash its surface by the aid of a soft brush with aceto nitrate of silver (twenty grains to one ounce of water); then rinse it in distilled water, to which a few drops of solution of fluoride of sodium or potassium has been added, and put it at once in the camera.

95. There are several other methods of obtaining very sensitive glass plates. By using pyro-gallic acid,

* In experimenting with other films than albumen, alcohol may be objectionable; if the plate be put into a well-closed box, having at the bottom a little fused chloride of calcium, it is very quickly dried.

as proposed by Mr. Archer, we obtain a surface very sensitive to luminous influence; he has not published his method of applying it to glass, but we find the following to be a very successful plan. Prepare an albumenized plate by the method given at § 87, with the iodide of silver alone, allow it to dry, then dissolve in one ounce of pure acetic acid 10 grains of nitrate of silver; in a separate bottle, put another ounce of acetic acid, to this add about five grains of pyro-gallic acid; now mix in equal volumes a small quantity of each of these solutions, pour it on the glass plate, spread it with a small piece of bibulous paper, shake off the excess, and use it immediately; it is exceedingly sensitive. To develope the picture, pour on to the plate a similar mixture used to excite it, a beautiful impression will be the result, being both positive and negative, the difference in character depending upon the way in which it is seen. These give much more intense positive pictures than can be produced by gallic acid.

96. An already iodised plate is also made exceeding sensitive by an extremely diluted ammonio-nitrate of silver. If we pour over an iodized plate (§ 87) a recently made solution of ammonio-nitrate of silver, containing about five grains of nitrate to one ounce of water, and then wash it well in distilled water, it is extraordinarily sensitive; the picture may be brought out by gallic acid, or better by the pyro-gallic acid mixture, described in the last paragraph (§ 95.) We have frequently obtained pictures in five seconds by these means, and believe, by varying the proportions, it may be done in sun light instantaneously.

97. *Method of converting Negative Photographs into Positives.*—In Mr. Hunt's valuable researches on light, he has mentioned that if we immerse an ordinary photograph on paper into a solution of corrosive sublimate it will entirely vanish, but may be restored at

pleasure by a solution of hypo-sulphate of soda. Now, this disappearance arises from the conversion of the dark shadows of the picture into a white powder, which is deposited in the pores of the paper, and is not distinguished from the white around (see also § 35); an apparently blank surface is, therefore, obtained; on glass the effect is somewhat different. When a negative on glass is put into bichloride of mercury (corrosive sublimate), all the black immediately disappears, and is replaced by a white powder; when the plate is taken out, washed in distilled water, dried, and laid upon a black surface, a most beautiful positive picture is obtained, quite permanent, and unacted on by light. Should we wish to convert it into a negative again, it is only necessary to pass it into a solution of hypo-sulphite of soda, and wash and dry it, when it will again assume its intense black appearance; by these means it is possible to have a positive or negative at will. We have often found that after the negative is restored by the hypo-sulphite, stains, which may have almost rendered it useless, have disappeared, and in general a much brighter print from it has been produced. In fact, the combinations on glass are so numerous, that it is unnecessary to detail them, believing that any person who experiments in this beautiful subject, may by looking over the published papers of Sir John Herschel, Mr. Hunt, M. Becquerel and others, on the action of light on paper impregnated with various photogenic materials, easily devise useful modifications and additions to our present knowledge of photography on glass plates, at the same time we should be sorry for each little alteration from the paper to the glass to be made the subject of a *patent monopoly.*

ANTHOTYPE.*

98. This is a general name given to those methods of producing pictures, in which the coloured juices of plants are the photographic agents; nearly the whole have been described by Sir John Herschel. The petal of the flowers should be crushed in a marble mortar and the juice expressed by squeezing the pulp in a clean cloth. It should then be spread upon the paper with great care, so as to be perfectly uniform all over, and then dried by spontaneous evaporation. It is better to add a little alcohol, as it prevents the paper from becoming changed by the air, which sometimes occurs very quickly when this precaution is not taken. The following are some of the results which are mentioned by Sir John Herschel: †—The flowers of the *Corchorus japonica* impart a fine yellow colour to paper, and, upon exposure to sunlight, in about half an hour it is rendered quite white.

Common Ten Weeks' Stocks.—Papers prepared with the alcoholic extract of this flower are of a very bright red, and are sensibly decolorated in a few hours. The Red poppy, *Papaver rhœas*, gives a very beautiful red colour, which is speedily bleached by the light, giving a positive picture.

If tincture of turmeric be spread upon paper, it is slowly acted upon; if slightly browned by an alkali, it is a little more sensitive. The *Viola odorata* gives to alcohol a rich blue colour, which is pretty rapidly bleached by light. The juice of the *Mimulus Smithii* gives a yellow colour, which is discharged by sunshine. The *Ferrarea undulata*, a dark brown flower, yields a

* From $\alpha\nu\theta o\varsigma$, a flower, and $\tau\upsilon\pi o\varsigma$, a picture.

† On the action of the rays of the solar spectrum on vegetable colours.—*Philosophical Transactions*, 1842.

juice which, if spread upon paper and exposed to light, turns to a blue. The French marigold, *Tagates patula*, imparts a colour to paper which passes rapidly from a brown to a green. We have lately found that the infusion of saffron in water washed over paper is very sensitive to light, the paper is quite bleached by strong sunshine in about ten minutes. Sir John Herschel, in his paper, enumerates a great number of other flowers, the colours of which are modified or discharged by light; he also gives the result of his experiments with them when acted on by the different coloured rays of light; he shows that the most active rays of the solar spectrum in discharging these vegetable tints are those which are *complimentary* to the colours themselves: thus the yellow ray of the spectrum will speedily discharge vegetable blue or purple, but will act very slightly upon yellow or orange, whilst the indigo and blue rays will speedily discharge these colours. It is worthy of remark, *en passant*, that the ordinary argentine photographic papers are most acted on by the *invisible rays* accompanying solar light (§ 5.); but those anthotypic preparations are only affected by the *coloured* rays of the spectrum.

Dr. Draper and Mr. Hunt have followed out this subject in its more extended view, viz., the action of light upon plants, but they appear to differ in many of their results, probably owing to the difference of the light they operated with, one living in England, the other in America. Mr. Robert Hunt placed seeds under different coloured glasses; these seeds were found by him to *germinate* under the yellow glass, but were not found to live and flourish; however, if removed, after germination, and placed under the blue, they grew and were very healthy. Mr. Hunt has been commissioned by the British Association to pursue this subject. From the investigations of this gentleman, it is certain that the whole of the carbon of a plant, and which constitutes

the greater part of its solid matter, has been derived from the atmosphere in which it exists united with oxygen and carbonic acid. This carbonic acid is decomposed by plants, when under the influence of light, into carbon and oxygen gas; the plant assimilates the carbon, and forms it into organized matter, and oxygen is liberated. Now this occurs just according, and in proportion, to the amount of light, or rather, to the quantity of actinic power existing at the time; for it has been shewn, that under yellow, green, or red glasses, plants grow but very imperfectly; or, in other words, they are unable to decompose the carbonic acid, in consequence of the absence of the chemical or blue rays. Every person must have noticed the sickly appearance of vegetation, if grown in a place where light is partially excluded; the leaves are nearly white, and if the plant does flower and bear fruit, the leaves are pale and scentless, and the fruit insipid. We have familiar examples of this when the gardener wishes to bleach celery or endive; he covers up the plants with earth, light is excluded, and they become quite white; the interior of a cabbage is white, and for a similar reason. These are interesting facts, for they shew how mutually dependent animals and plants are on one another. It is absolutely essential to animal life that the requisite quantity of oxygen should exist in the air, which myriads of animals are continually abstracting, in order to keep up a process of combustion, the product of which is carbonic acid; for on inhaling the oxygen from the air, it combines with the carbon contained in our bodies, and forms this noxious gas, which is exhaled, and deteriorates the atmosphere. Now, under the influence of light, this carbonic acid is decomposed by the vegetable kingdom, and pure oxygen gas set free, to be again absorbed by animals. In the words of Mr. Hunt, "It is not possible to conceive a more perfect or more beautiful system of harmonious arrangement than

this. If the vegetable world was swept away, animal life would soon become extinct; and if all animal existence was brought to a close, the forest would fall, and the flowers of the field, which now clothe the earth with gladness, perish in the utterness of a lamentable decay."

We have now conducted the reader through some of the most important and useful of the photographic processes on paper, and refer him to the second part of this work for a description of the Daguerreotype, Thermography, and other processes with metallic plates.

THE END OF PART I.

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